THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXVII. JULY 18, 1890. No. 660

CONTENTS:

	PAGE
State Control...	57
The Troyes Central Station...	60
The Electric Light at the St. Moritz Baths	60
The Electrical Conductivity of Air and the Formation of Ozone	60
The Taunton Dynamo (*illustrated*)	61
The Electric Light at Drury Lane Theatre	62
The Zigang Polyphone (*illustrated*)	62
Prof. Lodge on the Theory of the Electric Welding Process...	63
Steno-Telegraphy	66
Electrical Engineers at Edinburgh	67
The Telegraph Clerks and the New Scheme	67
Notes	68
City Notes, &c. :—The Eastern Telegraph Company	71
The Elmore Wire Manufacturing Company	72
National Telephone Company	73
United River Plate Telephone Company	74
Crompton and Company	74
Traffic Receipts	74
Share List of Electrical Companies	75
Electric Lighting and County Council	76
Barnsley and Electric Lighting	76
Reviews :—Derivation of Practical Units	77
Inventions and How to Patent them	77
Journal of the Institution of Electrical Engineers, No. 87	77
Alternating Current Motor (*illustrated*)	77
Action of Lightning upon the Human Organism	77
Proceedings of Societies :—	
The Institution of Electrical Engineers (*illustrated*) ...	78
New Patents	82
Abstracts of Published Specifications	83
Correspondence :—Secondary Battery Manipulation	83
Lubricating Oils	83
Telegraph Statistics in Australia	83
Electric Traction	84

STATE CONTROL.

IT was Lord Salisbury who remarked of governing bodies deputed by the State, "they begin by being enthusiastic and extravagant, and they are very apt to end in being wooden," an observation which was then, is now, and, probably, will be true for all time. At first enthusiastic, they are actively officious and dictatory, imposing all kinds of unnecessary restrictions, and, at last, wooden, they become afflicted with official paralysis, and reach a condition of functional impotence. Early they get in front and block the path of progress; later they get in the rear, and pull from behind.

But, in spite of all, the community cries for further State remedies, and for the appointment of more governing bodies. Though every week's intelligence brings us fresh tidings of official mismanagement and departmental maladministration, though times out of number our hopes in Government schemes have been crushed and our trust in administrative projects rudely betrayed, notwithstanding the lapse of time serves but to accumulate the evidence, month after month and year after year, is the same confidence shown in the power of officialism and the same faith displayed in the omnipotence of Government. Is the system of the Government inspection of vessels shown to lead to enormous bungling, then more inspection is insisted on. "When, after long continuance of coal mine inspection, coal mine explosions keep recurring, the cry is for more coal mine inspection. When a railway accident occurs, notwithstanding the oversight of officials appointed by law to see that railways are safe, the unhesitating demand is for more such officials." If a bridge is blown down, there is expressed a wish that the Government should institute a more complete system of inspection, and so on. "Daily we castigate the political idol with a hundred pens, and daily pray to it with a thousand tongues." Always the same unwavering trust is manifested, more government we must have, and if the department fails in its duty occasionally and an accident occurs, does it not make up for its neglect to some extent afterwards by—holding an enquiry!

It is vain in these days of advancing Socialism to preach against Government interference. In so doing, we are promulgating ideas opposed to the spirit of the age. According to the new lights, the time for individuation has gone by. Men are no more to struggle on their own behalf, but to give their services for the benefit of the community at large. Rewards are to be apportioned to merits as on the good old system no longer, but a condition of things exactly the reverse is to be ordained. Those, who by indomitable energy and untiring effort have succeeded in securing for themselves a share of the world's rewards, are to be mulcted of some portion by the State, that to the idle and the worthless and the undeserving may be given what they have not earned. Capital will have no rights under the new *régime*. The men who have accumulated it, those who have been self-sacrificing enough to surrender present pleasure for the sake of future enjoyment are denounced in no measured terms by the labour communists. If the new democracy is ever established, the capitalist will receive but scant consideration at its hands.

That all the great industries of our country will be controlled by the State, is included in this nineteenth century evangel. The coal mines are to be managed by Government officials. The Government must purchase the railways, and to its monopoly of telegraphy, it must add that of telephony. It is little use showing that outside the exercise of its legitimate function of protection the Government mismanages everything it touches, or in bringing evidence to show that State departments are invariably a decade behind private enterprise. It is matter of history that the Navy officials commit errors which the merchant service avoids. In taking precautions to prevent the corrosion of plates, in providing sufficient boats for saving life in case of accident, in furnishing efficient apparatus for quickly lowering boats, and in adopting a governor

to prevent the engines breaking down, they were years behind the merchant service. In refusing to carry fresh water apparatus, and in delaying the adoption of lemon juice as a cure for scurvy until forty years after a chief medical officer of the Government had given conclusive evidence of its worth, are exhibited the delays due to officialism. The use of compound engines and high pressure steam, the Government adopted long after it had been recognised as essential to economy by the mercantile marine. Nay, more, there is hardly at the present moment a British ironclad which will steam at full speed for twelve consecutive hours without something breaking down. Daily we hear of bungling at the Dockyards and of mistakes at the Horse Guards. Whether the Government builds ships or manufactures guns the work invariably costs more than if done by private contractors. If it makes weapons for soldiers' use, or coats for soldiers' backs, the same want of foresight and extravagance are manifested; and it is the same in all Government departments. Of course the Post Office will be pointed out as a Government monopoly, conducted on mercantile principles, and making a profit. But it is not proved that private enterprise would be unable to carry the work on at less cost. The Post Office progresses owing to pressure from without. It is brought into closer contact with the public than any other Government department, and though nominally under the control of officials it is virtually managed by the mercantile community. It it is not allowed to become inefficient, though its conduct is by no means above reproach. A department in which the officials spend a million and a half in two years without authority is conducted on a scale of recklessness which may well excite astonishment. But it bears out Sir Charles Fox's remark—that a Government office is like an inverted filter, into which you send accounts clean to come out muddy. Business conducted on such principles would for joint stock companies mean bankruptcy, for Government departments it means but additional taxation.

The efforts of the Government to control electric lighting manifest the same blunders as do previous attempts at industrial regulation. The purposes of the legislature being avowedly to protect individual interests and secure the public safety, we have already a number of restrictions formulated by the Board of Trade, which illustrate conspicuously the arrogance of officialism, but which are quite unnecessary either for the protection of interests or the avoidance of danger. That these restrictions seriously hamper the lighting industry is apparent to all. Divided in opinion as regards all the points on which amendment is desirable engineers may be, but on this one point all are agreed, that the regulations while unnecessary, constitute an actual hindrance to progress. Acts of Parliament, Model Orders and Regulations have been multiplied, and the confusion at the moment is so great that no one knows very well where we are; a fact, the knowledge of which may have influenced Major Cardew in no small degree when preparing his recent paper for the Institution. The fact is, the Board of Trade officials lack practical experience of the industry they endeavour to control, and a time will come sooner or later when the great mass of their regulations and provisions will be revoked, or will be set on one side, becoming of none effect. Electrical engineers know their business better than does the Board of Trade, and officials can only advance in knowledge as fast as those actually doing the work acquire the information gained from practice on a large scale. It will be found eventually that only a small amount of regulation is necessary, all save that required to enforce the due performance of the contract between undertakers and consumers, to secure the public safety and protect rival interests being consigned to the limbo of obsolete legislation. The history of electric lighting measures, when it comes to be written, will pretty much resemble the history of others. We have first the Measure, then the period during which it is discovered to be a mistake. We have next an amendment Act, followed by attempts to work under its provisions. Finally, we have the repeal succeeded in due course by another legislative experiment in the shape of a fresh measure. So it has been, so it will be. The everlasting trial and error continues, each Parliamentary session bringing new Acts, further amendments, and fresh repeals.

The P.O. Joke.

IN the last issue of *Engineering* there appeared an article on the electrophonoscope on the lines taken up by us the week before. Not only did many of the daily newspapers extol the great invention of the day, says our contemporary, but, the editor of a technical journal, which assumes that it is in the confidence of the electrical profession, was drawn readily into the snare. It certainly will be interesting, remarks *Engineering*, to see how our contemporary will climb down; perhaps by implying that, he knew it all the time, and would not spoil the little game. We do not think it difficult to identify the journal in question, but up to now we have seen no further reference to the matter in its pages.

The Electric Tramway in Buda-Pest.

IT is gratifying to learn that this line has so far proved a great success, both from the technical and commercial point of view. Our readers will remember that the Buda-Pest electric tramway was designed and constructed by Messrs. Siemens and Halske, and it was formally opened in September, last year. During the month of April of the present year it carried 337,200 passengers, or 42,684 passengers per kilometre, the line being 7·9 kilometres in length. There were 20 motor cars in daily use, excepting on Sundays and holidays, when four additional cars were called into requisition which were attached to four of the motor cars. The city possesses a horse tramway of 45·6 kilometres length, and 329 cars, which carried in the same period 33,074 passengers per kilometre, or 9,610 less than the electric tramway. Calculating the "duty" for each vehicle, it will be found that each electric motor car carried 16,860 passengers, whereas each horse car carried only 4,584 persons in the same period. The fares on the electric tramway are considerably lower than on the other lines, yet during the month mentioned, the earnings of each electric car came to 1022·95 florins; the horse car, on the other hand, earning only 369·81

florins. These figures would show that the commercial efficiency of the electric cars is much higher than that of the horse cars, and it is explained that this is mainly due to the much greater speed (18 kilometres per hour), of the former, which more than doubles the earning capacity of the line. The proportion was even greater in May last, when 387,000 passengers were carried on the electric tramway. We have no exact figures concerning the working expenses, but we are assured that they are lowest with the electric system.

"As Old as the Hills."

ONE would have imagined that an esteemed contemporary, conducted in the interest of certain submarine cable companies, would have known sufficient about the testing of faulty cables to have prevented falling into the error of publishing in last week's issue an illustrated article on "A Method of Localising Partial or Dead-earth Faults in Insulated Conductors," as if the method described was something novel and particularly interesting. The method is as old as the hills; or, perhaps, more correctly, as venerable as insulated conductors. It would be very difficult to give an exact period to its earliest discovery; but it is ancient, very ancient. When in the old days insulated conductors in the form of core or cables were found to be faulty, this method was so simply obvious that it was used. When the core was coiled the battery wire was attached to the end and there kept as the core was run off; but in the case of the insulated wire being on a revolving drum or "swift," there was no difficulty in making and maintaining the necessary contact. It is very interesting to observe how very frequently the electrical engineer of the present day discovers methods of doing simple things which were known years ago to the telegraph engineer. It was a pity that the method, to which we have just alluded, was not patented and brought out by some eminent firm or company.

The Directors' Liability Bill.

IN the House of Lords, on Tuesday, Lord Herschell moved the second reading of the Bill. He said there had been a good deal of misconception in relation to its scope and object. The Bill would not deal, and was not designed to deal, more effectually with fraud than the law at present deals with it. The purpose of the Bill was to deal with persons who make untrue statements honestly, but without reasonable ground for believing them, with a view to inducing others to invest their money, or embark in any undertaking. He admitted that some of the details of the Bill were open to criticism. It was not clear, for instance, whether promoters were within its scope, yet in many cases they were the persons whom one would really like to hit; and it was certain that persons whose names were merely mentioned in the prospectus, as the bankers who received subscriptions, or the solicitors who gave the company legal advice, ought not to be held responsible for every statement put forward by the directors. "Responsible for" were very wide, and, to his mind, objectionable words, because responsibility was a question for the law to decide. The Lord Chancellor, while sympathising with the object of the Bill, had not the slightest hesitation in inviting their lordships to reject it in its present form. Lord Bramwell presented a petition from the London Chamber of Commerce, in which the petitioners stated that they viewed the Bill with very great alarm, and expressed their firm belief that if it passed as it at present stood, no man of means and repute would allow himself to be a director of a limited liability company. He agreed with the Lord Chancellor that if it were a question of this Bill passing as it stood he should heartily vote against it; and Lord Esher remarked that not a single line of the Bill would stand examination. Lord Herschell did not know that any legislation of the kind could safeguard reckless investors from loss. The Bill was read a second time, and referred to the Standing Committee on Law. It is almost a pity that amongst those held "responsible," the scientific expert was not included, for many a worthless scheme has been floated purely on the strength of a gushing report from some well-known professor or expert. Our opinions on the Bill, as a whole, may be read in the REVIEW for July 4th, page 11.

Scientific Reporting.

IT is more than probable that the report on a new incandescent lamp, to which we called attention in our last issue, did not emanate direct from the Professor who carried out the experiments, but from interested parties who placed their own construction upon the loosely tabulated figures which we have since had an opportunity of examining. Nevertheless, we feel it our duty to point out how a report, seemingly guarded, may be made to indicate almost anything that is desired, and also how careful one should be to see that the calculated results contain no errors. The new lamps, which we will still designate as those of X, were 16 in number and of five different voltages, viz.:—110, 105, 100, 92, and 80. The voltage was adjusted to give the candle-power the lamps were intended to produce, which was 16. The entire batch was then averaged, a manifestly unfair proceeding when pitting the results against 100 volt lamps of another manufacture, the watts per candle-power being given as 3·778. The Edison-Swan lamps, only four in number, were tested in the same manner, and the watts per candle-power averaged, according to the Professor's data, 4·21. Naturally this looks somewhat uneconomical for the old lamps as compared with the new, but let us examine the tests. In the following table the working out of the watts per candle-power by the Professor appears in col. A; our own calculations in col. B.

Lamp.	Volts tested at	Ampères.	Watts.	C.P.	Watts per C.P. A.	Watts per C.P. B.
No. 1...	98·9	0·643	63·6	16	3·97	3·97
„ 2...	98·3	0·628	61·7	„	4·14	3·85
„ 3...	98·2	0·631	61·9	„	4·16	3·87
„ 4...	101·4	0·652	66·1	„	4·58	4·13
					4·21	3·95

Now 3·95 is not greatly in excess of the averaged watts per candle-power of the 16 new lamps of five distinct voltages, but if we take those of 100 volts, curiously enough, also four in number, we find the average to be 3·90. Instead, therefore, of the new filaments taking less electrical energy than the Edison-Swan, we find that they are practically alike, for naturally we must select those lamps for comparison which require approximately the same voltages to give a like illuminating power. There are other points in this report to which we could take exception, but enough has been said to show that such statements as appeared in our last issue must be taken *cum grano salis*, and we shall endeavour to keep a watchful eye on the future proceedings of the owners of X's lamp patents.

THE TROYES CENTRAL STATION.

WITH a flourish of trumpets the Compagnie Nationale d'Electricité (Ferranti's system) inaugurated on the 21st ult. the central station at Troyes. Mr. S. Z. de Ferranti went over from England to be present at the ceremony which was rendered rather sad by the death of an employé who was killed by a shock from a transformer which he grasped to save himself from falling down a cellar. At a meeting of the municipal council, the mayor, in reply to questions, stated that the company had strictly carried out the prefectural regulations, and that no blame was attached to them.

The station is situated in the suburb of Sainte-Savine, and the plant comprises two Babcock and Wilcox boilers, one Brasseur steam engine of 150 N.H.P., and one Ferranti dynamo giving 50 ampères at 2,400 volts. As the demand for light increases it is proposed to instal two similar groups of machines. Underground two wire conductors are employed and extend about 4½ miles. The cables are well insulated, and are protected by an external steel wire covering. Insulated branches are jointed to the mains, which are laid at a depth of about 20 inches in the ground. The distribution is effected at an E.M.F. of 100 volts, and transformers are erected in certain places according to the consumption; current is supplied both for public and private lighting. In the former case arc lamps of 8 ampères and 50 volts are used, and in the latter incandescent lamps, of which there are 800 already in use. Light is sold at a fixed sum per lamp hour, and each subscriber has installed a Ferranti-Borel meter modified and graduated in lamp hours. The rent for the meter varies from 1s. 3d. to 4s. 10d. per month, according to the capacity. The price per lamp hour of 10 candle is ⅜ of a penny, and for one of 16 candles about ½ of a penny. Those persons using the light subscribe for five years, and guarantee a minimum consumption of light amounting to 29s. per annum. The company has to pay to the town a rent of 2d. per metre of mains laid, including the return.

THE ELECTRIC LIGHT AT THE ST. MORITZ BATHS.

THE electric illumination of watering places on the European Continent has made, of late, very satisfactory progress. The favourably known health resort, St. Moritz Baths, near Engadine, in the Canton of the Grisons, Switzerland, is about to become possessed of a very interesting installation for electric lighting.

The first step is the construction of a large central station at Silvaplana, where water power is being derived from the Julien brook, with a fall of 35 metres. From here the power for the electric lighting of the entire watering place will be conveyed over a distance of 5½ miles. The installation will be arranged by the machinery works of Stirnemann and Weissenbach, of Zürich, who three years ago fitted up the Hotel Kulm at the village of St. Moritz (near the St. Moritz Baths) with about 2,000 glow lamps.

The central station at Silvaplana will have, at first, a capacity of 3,000 glow lamps. For this purpose three turbines will be set up, each of 125 H.P., each of which will be directly connected with an alternating current machine, type WA_6. Each of these alternating machines, at a rotation of 250 turns per minute, furnishes a primary current of 27 ampères and 3,000 volts tension, and is excited by a continuous current machine of the Ganz type, $\triangle_2$. The regulation is effected partly by manual rheostats (one for each alternating current and exciting machine) and there is besides an automatic current regulator with a reducer and equaliser.

The water arrangements in the mountain stream, which is very violent, will be effected on the plans of the firm Largin and Grossmann, of Lucerne. The turbines and their accompanying regulators are being furnished by the firm Rieter, of Winterthur, and the electrical machinery and the transformers by the firm Ganz and Co., of Budapest.

Three prominent establishments at the St. Moritz Baths will be at once supplied with the electric light.

The Bath Saloon with 700 lamps and four arc lights.

The Hotel Victoria with 700 glow lamps and three arc lights, and

The Hotel Dulac with 938 glow lamps and seven arc lights.

In these buildings there will be set up 18 transformers, each of the capacity of 8,000 watts, which convert the primary current of 3,000 volts into a secondary current of 110 volts. Of the three alternating current machines in parallel insertion, two are to perform the normal service, whilst the third is kept in reserve.

The distance between the central station at Silvaplana and the first point of distribution (the Bath Saloon) is 4,800 metres; the total distance from the central to the most remote point to be illuminated is 5,400 metres.

With reference to the high tension prevailing in the primary leads (3,000 volts) special insulators for high tensions are being supplied by the firm Johnson and Philips, of London.

The entire installation must be complete in the spring of 1891, so that the electric light may be in action at the commencement of next year's season.

THE ELECTRICAL CONDUCTIVITY OF AIR AND THE FORMATION OF OZONE.

MORE than a hundred years ago Van Marum observed that when an electric spark is passed through a vessel containing oxygen gas, a peculiar odour is developed and the gas becomes more chemically active; thus oxygen, which has been treated in this way, will at once tarnish the bright surface of mercury.

Nearly 60 years after this interesting discovery, namely, in 1840, Schönbein wrote calling the attention of scientists to it in Poggendorff's *Annalen der Physik und Chemie*, vol. iv., p. 616. He stated that the action of the electric spark converted the oxygen into a new body, for which he proposed the special name of ozone, a word which is derived from a Greek verb meaning "to smell."

Schönbein described many of the properties of this ozone, and, amongst them, that special property of being able to liberate iodine from potassium iodide, which has since been made the basis of a characteristic test for ozone.

Ozone is capable of effecting many remarkable oxidising reactions, and on this account has been the subject of much attention from chemists. In the early fifties it was a great *crux*, quite a bone of contention amongst the leading chemists, who were greatly puzzled concerning its constitution; amongst others, Baumert, Williamson, Frémy, Becquerel, Marignac, De la Rive, &c., joined issue.

The exact nature of ozone was discovered by Andrews (vide *Philosophical Transactions*, 1856, p. 13). He succeeded in proving that ozone is not a compound of two or more elements, as Williamson and Baumert held, but that it is merely oxygen in an altered state, or, as chemists say, in an allotropic condition.

If a series of electric discharges be passed through dry oxygen gas, a portion of it is converted into ozone, and the change is accompanied by a diminution in bulk. Chemists explain this by assuming that three volumes of oxygen condense to form two volumes of ozone. And this theory is supported by experimental evidence, most of which has been supplied by Soret (vide *Annales de Chimie et de Phisique*, series 4, vol. viii., p. 113, and *Philosophical Magazine*, series 4, vol. xxxi., p. 82; vol. xxxiv., p. 26.

Ozone can be produced in a variety of ways, thus:—

1. It is evolved at the positive pole during the electrolytic decomposition of acidulated water.

2. It is formed by the slow oxidation of phosphorus in air.

3. It is obtained when the discharge from an electrical machine is passed through dry air, or, better still, through dry oxygen gas. The silent discharge converts a portion of the oxygen into ozone. A Siemens's induction tube is the best apparatus for this experiment.

4. It is obtained by the action of a heated glass rod on a mixture of ether vapour and air contained in a beaker.

5. When a stream of air is passed on a platinum wire heated to whiteness by means of an electric current, ozone is formed.

6. It is produced during the combustion of all substances containing hydrogen in the air or in oxygen, hence it is found surrounding the flame of hydrogen, alcohol, candles, coal gas, &c.

Ozone is always found in the air which is in the vicinity of a Bunsen gas flame. Further, it is a well-known fact that air in the vicinity of such a flame possesses considerable electrical conductivity. These facts have recently attracted the attention of Messrs. J. Elster and H. Geitel, who have endeavoured to discover whether any relation exists between them. They contribute an interesting paper upon their research to the *Annalen der Physik und Chemie*, series 2, vol. xxxix., p. 321.

Suspecting that the electrical conductivity of the air in the neighbourhood of a Bunsen flame might be due to the formation of ozone, Messrs. Elster and Geitel were led to examine the electrical properties of the air enveloping a stick of moist phosphorus undergoing slow oxidation with the formation of ozone. They obtained data in their experimental investigation which enabled them to decide that the process of converting oxygen into ozone in this case, also, determined a similar assumption of electrical conductivity by the air. They were unable to demonstrate, however, that any electromotive force was connected with it.

It seems, therefore, from these experiments, that the mere *presence* of ozone is not in itself sufficient to impart electrical conductivity to the air, though there does seem at first sight to be some connection between the two.

Other experiments were instituted with a view to throwing side lights upon this question, and it was shown amongst other results that the formation of solid particles of ammonium nitrite in the neighbourhood of the stick of phosphorus did not exert any appreciable effect. A curious effect was observed, namely, that the formation of ozone is hindered by the presence of oil of turpentine, and that the electrical conductivity of the air at once disappears when some of the vapour is introduced. Not only turpentine, but several of the essential oils, when acted upon by atmospheric air, transform a portion of it into ozone, and again turpentine will absorb ozone without decomposing it. These interesting results seem to indicate that there is room for still more research in this direction, which should be especially attractive to physical chemists, that is to say, to those scientists who delight in exploring the borderland between physics and chemistry.

THE TAUNTON DYNAMO.

THIS new pattern dynamo is of the two-pole type, built by Mr. F. M. Newton and designed by Mr. T. Hawkins. The machine has been exhibited at the Royal Show at Plymouth, where it was used to charge a set of batteries and to light Messrs. Priestman's stand being driven by one of that firm's 2-H.P. oil engines. The dynamo under consideration is shunt-wound, gives 30 ampères at 90 volts at 1,180 revolutions per minute, and runs cool on full load with an efficiency of 93 per cent.

The field magnets are made of the best wrought iron, bolted to the bed plate where the cross section has been increased, and the armature has one layer of wire wound drum fashion. There are only two turns of wire per commutator bar.

There is no lead to the brushes, and the work can be increased 50 per cent. above full load without sparking; in fact, there is no need for a rotating brush holder, and the makers intend discarding it unless specially ordered.

The machine is well designed and the bearings are long, fitted with white metal, and have sight feeding lubricators. These machines are being made in different sizes from 1 unit to 30; machines larger than this are of the four-pole type designed by Mr. Newton.

THE ELECTRIC LIGHT AT DRURY LANE THEATRE.

INCREASED SAFETY.

AT the annual meeting of the Drury Lane Theatre proprietors, held last Friday in the saloon building, under the presidency of Mr. Cornelieus O'Dowd, Mr. C. J. Phipps, the architect, presented a report with reference to the condition of the theatre, stating that during the year there had been an installation of the electric light throughout the building.

The Chairman, in moving the adoption of the report, stated that although the institution of the electric light in the building did not bring any money into the pockets of the proprietors, they considered that it added very much to the safety of the theatre, and they therefore felt themselves justified in undertaking a moiety of the expense, the agreement with Mr. Harris being that he should pay half the expense of the electric lighting. In explaining the accounts, Mr. O'Dowd said that during the past year they had paid £1,260 for the institution of the electric light, their contract with the lessee being that he should pay half of that on the completion of the work, but as the work was not completed at the time the accounts were made up, his payment in respect of it had not yet been received, and therefore was not credited in the accounts. The proprietors would have to pay down in all about £350 more in respect to the electric light and the lessee. Mr. Harris would contribute one half. He (Mr. O'Dowd) would like to say that in addition to the establishment of the light on the stage and the auditorium, they had had it put up in other parts of the theatre.

Major Sharpe, in seconding the motion for the adoption of the report, said that he looked with much satisfaction upon the installation of the electric light, as he considered it added very much to the safety of the theatre.

The report was unanimously adopted.

THE ZIGANG POLYPHONE.

IT is well known, writes M. Ed. Hospitalier, in *La Nature*, that the vibrating plate of a telephone may be made, under the influence of undulatory electric currents, with the necessary graduations and modulations, to reproduce all the sounds and the tones the most diverse in a gamut of the most extended scale, with only the slight and almost imperceptible alteration which is due to the fundamental sound of the vibrating plate itself. This will not be the case if we make use of the plate to modulate the current. We have already had occasion to describe M. Zigang's electric trumpet, in which a current being periodically interrupted by the vibration of the plate produces a continuous sound of peculiar tone. This electric trumpet constitutes an apparatus midway between the telephone and the electric bell, for which latter it may be substituted with advantage in a great number of cases. The first of M. Zigang's trumpets were somewhat disagreeable in sound, and the pitch was often ill defined. By rearranging the whole system with entirely metallic fittings, by suitably modifying the thickness of the plate, its diameter, peripheric mounting, the armature mass, the capacity of the resonator, and the proportions of the electro-magnet, the sound was perceptibly improved. It acquired a tone approaching to that of the hautboy, one which could be modified to considerable extent by a well arranged combination of the various organs contributing to its production. But M. Zigang aimed at something more. He aimed at transforming the monophonic trumpet, which was only capable of a single, with a perceptibly uniform, pitch, into a polyphone, or a single apparatus capable of emitting several well defined notes. He succeeded in this by turning to advantage the connection existing between the pitch of the principal sound furnished by the vibrating plate and the diameter of the latter. The following figures illustrate the principal dispositions of the apparatus, as well as the mode of putting them in action.

The polyphone is no more than the original trumpet formed out of an electromagnet (fig. 1) mounted in front of a vibrating plate, to which a soft iron armature, A, is attached. A platinum contact, V, closes the circuit of a battery upon the electro-magnet, and breaks it as soon as the plate is attracted, in order to establish it anew when the plate has recovered its initial position, and so on. The sound which is thus emitted is that corresponding to the natural vibration of the plate under the influence of the periodical creation and suppression of the currents traversing the electro-magnet. But by applying a blunt point to the plate we immobilise the entire portion of it comprised betwixt the periphery of the plate, which is fitted to the mounting, and the concentric circle which passes through the point touched. The plate thereupon emits an acute sound, which is the more acute as the point touched is nearer the centre. By touching different parts of the plate it may be made to

FIG. 1.—ZIGANG'S POLYPHONE.

FIG. 2.—EXECUTION OF A MUSICAL AIR ON THE POLYPHONE.

emit different sounds with a certain correspondence between the tones and half-tones of the chromatic scales; so that it is possible to obtain real music. This M. Zigang actually did, although the entire extent of the instrument was no greater than an octave. Each note is struck by pressing a contact button, B (fig. 1), with the left hand, whilst with the right we manœuvre the blunt point upon the surface of the plate. The connected movements are particularly facilitated by means of this instrument, upon which the inventor has already played several pieces arranged for it and for the piano. It would be possible to add to the apparatus special dispositions allowing of the easy realisation of the *forte* and *piano* notes. This might be done by introducing variable resistances into the circuit, either by varying the number of the elements by means of a commutator or by introducing into the circuit an iron-cored coil so as to modify the circuits coefficient of self-induction and thus enfeeble or enhance the intensity of the sounds at will. But it must not be lost sight of that the pitch of each fundamental sound is a function as well of the electric source and the interpolated resistances; so that the position of the contact corresponding to a note of given pitch is not always the same, but varies with the intensity of the sound obtainable, and which fact renders the performance somewhat complicated.

Nevertheless, M. Zigang's polyphone is an original and diverting instrument, and it has appeared to us worthy of being presented to our readers, if only because of its simplicity and of the experiments which it enables us to make for the purpose of imparting and demonstrating not a few of the principles of musical acoustics.

PROF. LODGE ON THE THEORY OF THE ELECTRIC WELDING PROCESS.

By S. ALFRED VARLEY.

IN the columns of *Industries* of June 27th, there is a communication from Prof. Lodge which purports to be of the nature of a reply to recent articles of mine which have appeared in the ELECTRICAL REVIEW.

It is not without significance that Prof. Lodge should have preferred his comments to appear in a journal, many of whose readers will, in all probability, not have read my articles.

Prof. Lodge lays stress upon the fact that when two iron bars are welded by electric alternations, the circuit is completed in the first instance through a small section of iron only, such section becoming gradually increased, as the heat electrically developed renders the iron soft enough to be forced together mechanically, the whole section eventually being brought into electrical contact. I directed attention *more especially* to what was observed when a solid cylindric bar of iron was heated between the jaws of the electric welder, as will be seen from the following passage which appears in my published criticism of Sir William Thomson's paper on Lord Armstrong's accidental experiment:—

In the course of these experiments iron bars of as large a diameter as 1½ inches were welded, and *cylindric iron bars* of various diameters *were heated* to a white heat, a rectangular frame of cylindrical iron, forming a continuous circuit, was also placed in the jaws of the welding machine; this arrangement was something like a Wheatstone's balance, there being two paths for the current, which became divided through two arms of unequal resistance, the shorter conductor being only a few inches in length, and the longer one, say, four feet. The object of this experiment was to show that under such conditions the whole of the current practically passed by the shorter route, which became raised to a white-hot temperature, the longer one being grasped in the hand of a workman all the time the experiment was being performed.

Both Sir William Thomson and Prof. Lodge have assumed responsibility in respect to the development of the newer theory, and I invited them, on public grounds, to refute the *main* contentions of what I had brought forward, if they considered them to be erroneous. In my criticism on Sir William Thomson's paper, one of my contentions was, that what was seen to occur, when solid iron bars were heated in the electric welder, did not suggest in any way a crowding of the currents in the outer skin of the bar heated. According to the newer theory, when the iron frame forming a continuous circuit, referred to in the quotation, was placed in the welder, as the passage of the electric alternations through the mass involves overcoming inertia, the currents should have been crowded into the outer skin only, the central portion remaining "stolidly inert;" and further, seeing that the energy transmitted by the transformer was great enough to heat the section throughout to a white heat, if Sir William Thomson's explanation of Lord Armstrong's accidental experiment be the true one, then the outer skins of the two electrical paths through which the currents were being divided should have been too highly heated for the human hand to grasp.

In the article which has drawn forth this communication, Prof. Lodge has confined his comments to the electrically heating two iron bars forced together mechanically, and I cannot help thinking he has done so, because what then occurs is somewhat more complex, and therefore lends itself more readily to argument.

In the course of my articles, from common sense developments of older theory and direct observation, I have built up what I consider to be a very complete structure, every part of which harmonises with those well ascertained laws that are recognised by physicists generally.

The test we have a right to demand is that all developments of theory should harmonise with established laws, and render clearer what was known previously in part.

What led me in the first instance to oppose a theory, our mathematicians claim to be so great an advance forward, was the fact that it neither harmonised with, nor did it help us to more clearly understand, previous observations. I, myself, have reason to be thankful for having realised in my youth that two great principles—viz., harmony and continuity run through all physical phenomena, and any claims I may be considered fairly to have, either as a discoverer or pioneer of scientific advances, are attributable solely to a clear recognition that physical phenomena are all of them connected with one another, and that therefore one should suspect the truth of anything put forward, however plausible at first sight it may seem to be, if it does not harmonise with our *commonest* everyday observations. Those who really love knowledge for its own sake, and who find a pleasure in mastering the principles underlying all physical science, have often an intuitive feeling of the direction in which truth lies, and the discoveries they make are seldom accidental, they not uncommonly see truths a long way ahead, which they can look forward to realising, it may be years later, if only they are not in the meantime anticipated by some one else; but in these days of so-called advanced ideas the great thing sought for in public scientific lectures and presidential addresses is the sensational, something out of harmony with our humdrum everyday experience, and the more sensational it is, and the more it lends itself to argument, the more it is liked by the scientific talker who reaps a harvest of reflected glory by retailing and trumpeting the sensational utterances of greater men to audiences only too ready to be astonished and amused.

Those whom Society permits to make sensational presidential addresses are almost invariably men of distinction, having a deservedly recognised official scientific status, and, if criticised, the orthodox proceeding is to fall back upon professorial caste, and professional etiquette; should this fail, the arts of sophistry are commonly had recourse to, and exhausted.

In what I have published from time to time, since the Dr. Mann lectures of Prof. Lodge were delivered, I have traced the connection between a whole series of physical phenomena which mathematical physicists have regarded separately, and dealt with, as though they were not in any way connected. In this way I have been able to get round physical phenomena to some extent, and to look at them from several points of view, and, as a consequence, I feel that the position I have taken up, in respect to the newer electrical theory, is a very strong one. I go further than this, for I venture to express the opinion that both Sir William Thomson and also Prof. Lodge are well aware it is so.

The accumulated observations of a life largely devoted to scientific research has resulted in the development of a very simple theory, which, among other things, has enabled me to explain, in a natural common sense way, what at first sight seemed anomalous in Prof. Lodge's "Alternative Path Experiments." According to my theory, performing a physical act involves the overcoming inertia — the overcoming inertia involves a transformation of energy, and every transformation of energy involves a storage of energy in matter to the extent that inertia has been overcome. It will be found that by this simple theory all physical phenomena can be connected together in a continuous chain, and that they can all of them be traced back to a simple duality—viz., active or positive energy, and inertia or negative energy. The active energy is external to the matter acted on, and when it becomes associated with matter such association is a more or less unstable one. Negative energy, on the other hand, is inseparable from matter under all known conditions, and is the most characteristic feature of matter—viz., inertia or weight.

In all physical acts or transformations of energy, for they are convertible terms, the positive and negative energies concerned are necessarily balanced, similarly as is the case in electrical phenomena, and whenever a transformation of energy occurs, the transformation in some cases results in a temporary association of positive energy with the negative energy of matter only, and in others there results a more or less stable combination. As a case in point, interpose a copper conductor in an active dynamo circuit, a certain amount of energy then becomes transformed into magnetism at the time the circuit is closed, and energy will also be transformed into heat, the energy transformed into magnetism remains statically occluded all the time the circuit is complete, but the energy transformed into heat is only temporarily and unstably associated with the matter of the conductor in which it is developed; in fact, in some cases, as fast as energy is being transformed into heat it passes out of the conductor by radiation, and in other examples, such as electric welding, the heat becomes transformed and stored faster than it can escape by radiation, and in such cases there is an unstable association of positive energy with the matter of the conductor.

The transformation of energy into heat in an electric circuit is dynamic, whereas the transformation of energy into magnetism is a statical occlusion, and in all cases where positive energy becomes combined with matter, forming a more or less stable combination with it, the positive energy is statically occluded.

When a copper electric circuit is divided, the energy which was transformed into magnetism and statically occluded at the time the circuit was closed, is parted with *completely*, the copper conductor passing from the magnetically polar to the normal condition very rapidly, and the energy which remained occluded all the time the circuit was complete, becomes now dissipated through the medium of current developed during the act of demagnetisation. If an iron conductor be interposed in a dynamo circuit, the transformation of energy into magnetism that then occurs will be enormously greater than when a copper conductor is interposed; but when the circuit is divided, the energy transformed and occluded as magnetism will be parted with much more slowly than was the case with the copper conductor, and some of it will be retained; the iron conductor, unlike the copper one, remaining more or less permanently magnetised; and here we have an example of a more or less permanent combination of positive energy with matter.

A plating bath is an example where no storage of energy occurs, or, to speak more correctly, where no work is done beyond that involved in overcoming conductive resistance, energy is certainly unlocked at the anode to the extent that the anode is broken down; but it becomes transferred to the cathode, where it builds up a structure the equivalent of that destroyed at the anode. In the case of a storage battery, where lead is oxidised, or a low oxide is converted into a higher oxide, altogether new structures are reared, and a very large transformation of energy occurs, the energy transformed becoming statically occluded in the new structure produced, which, being a very unstable edifice, readily parts with the positive energy entering into its structure whenever the conditions are at all favourable for doing so. Structures such as those developed in storage batteries are fairly comparable to fulminating compounds, which are simply very unstable structures, having relatively to their mass a very large amount of positive energy unstably occluded. From fulminating compounds we may pass to organic matter, such as wood or coal, and from organic matter we pass on by easy stages to such metals as gold or platina, which are very stable structures, and not readily broken down.

The cases cited are a few illustrations of the way physical structures, and the forces associated with them, are all of them connected, and the simple theory developed by me, and published in the columns of this Journal, will be found to join them all in a natural, common-sense manner.

The most unstable association of positive energy with matter is undoubtedly a statical accumulation in a Leyden jar, and the next in order to this is a statical occlusion of energy in the form of magnetism in a copper conductor closing an electric circuit, for in both these examples there is no affinity between the positive energy and the matter it is associated with, the accumulation of energy being maintained solely by pressure.*

Now let a mechanical illustration be briefly considered. (1.) Suspend a block of wood by a long string, and set it swinging by the hand; the whole of the energy imparted to the block in this way will practically take the form of motion, and it will be eventually, but slowly, parted with in the form of heat. (2.) Strike the block with a mallet and a percentage of energy will be at once converted into heat; but the greater percentage of energy transferred to the block will still probably be in the form of motion. (3.) Fire into the block a rifle bullet whose weight, multiplied by the square of its velocity, equals that of the mallet, and assume the bullet becomes buried in the wood, very little motion will be imparted to the block, nearly the whole of the energy associated with the bullet becoming transformed into heat.

Now let us consider what occurs when a Leyden jar discharges through an air space and a metal path. Energy accumulated as statical charge may be fairly regarded as a projectile unhampered by weight, whose speed under mentally conceivable conditions is infinitely greater than that of any rifle bullet, the time occupied by a Leyden jar in discharging being determined *solely* by the conditions that prevail in the path of discharge. Energy in the form of a statical electrical charge requires a path much in the same way as a fluid does, and space devoid of matter opposes as impenetrable a barrier to its passage as a solid mass of metal does to the flow of water; the path of discharge consists of an air space and a metal conductor, and as there is a great deal more matter in the metallic conductor than there is in the air space, and as inertia increases as the mass, it is in the metallic portion of the

* The rate at which a copper circuit demagnetises, is determined by the conductive resistance of the circuit.

path that inertia is chiefly encountered, and where the transformation of energy mainly occurs.

The vehicle of transmission of a Leyden jar discharge is the electricity of the path itself, and if due allowance be made for the fact that neither energy nor its vehicle possess weight, then it will be found that a Leyden jar discharge comports itself in respect to metallic conductors very similarly to that described in reference to the mechanical illustration. In the mechanical illustration a much larger percentage of the energy was transformed into heat when the bullet was fired into the wood, than was the case when it was struck with a mallet; and so, also, a much larger percentage of the energy of a Leyden jar discharge, if of very high potential, becomes transformed into magnetism developed in the metallic conductor than would occur if the same amount of energy were statically accumulated in condensers having a much larger surface than the Leyden jar, and in which case the potential of the energy, and the rate of discharge through the paths, would be greatly reduced.

I have in previous articles emphasised the fact that the energy of a statical charge is a limited quantity; and if I am right in maintaining that overcoming inertia in a metallic conductor is simply a transforming of energy into magnetism, then it follows as a truism that the greater the mass in the conductor the larger the percentage of the energy that becomes so transformed; and, further, that the magnetism developed, however large the conductor, can only approach to, but never exceed, the total amount of energy accumulated in the Leyden jar.

If only the continuity which runs through all physical phenomena be recognised, I think it must be seen how naturally what is observed in connection with Leyden jar discharges through metal paths falls into its proper place.

With the assistance of the newer development of electrical theory, Prof. Lodge has not been able to give a clear and intelligible explanation of his own "alternative path" experiments. My theory, on the other hand, not only explains Prof. Lodge's recorded observations in an understandable manner, but they become so plain and simple, that I have felt myself warranted in predicting that certain results will be obtained, if the alternative path experiments be repeated under certain conditions which I have specified. Now, if I can not only explain, but can also predict, where mathematicians cannot even explain, then it follows that my simple theory is a much more serviceable one than a complex theory, demanding the highest mathematics for its development.

My theory has been developed from direct observation and common sense reasoning, and I have shown in the course of my articles, that it has a much wider application than simply dealing with the experiments exhibited in connection with Prof. Lodge's lightning conductor papers. I have analysed inertia, which, as far as I know, no other physicist has *ever even* attempted to do. I have also, in no small degree, analysed the composite phenomena grouped together by mathematical physicists under the common term self-induction, and I have dealt also with the phenomena covered up by the term hysteresis.

In the analysis I have given of self-inductive phenomena, I have limited the term self-induction to the mutual induction between magnetised molecules on one another, and in my criticism of Thomson's paper on Lord Armstrong's accidental experiment. I called attention to certain matters in connection with electric welding, which I said I considered mathematicians could fairly claim as qualifying what was observed, and I pointed out that as iron looses its susceptibility to magnetism at a red heat when iron is raised to such temperature, the magnetic induction between molecule and molecule should cease, and therefore the inertia resistance opposed to rapid alternations in the direction of the electric currents should become very much reduced when a bar of iron in the welder reaches a red heat. Now I believe I am the only one who has pointed this out, and I was able to do so because of the analysis I had made of the self-inductive phenomena which occurs in closed electric circuits, and which, as far as I know, no mathematical physicist has ever attempted to make. I am sorry to have to say it, but Prof. Lodge seems to me to have taken advantage of what I am the only one, I believe, who has called attention to, without giving me the credit for it, but the giving me credit for the accomplishment of scientific work is what certain of our physicists find it so difficult to do. I have not been trained in the orthodox schools, and I seem to be considered out of the pale of sectarian scientific salvation. The gist of Prof. Lodge's comments, which appears in *Industry*, relates to the reduction of self-induction which I suggested (in my criticism of Sir William Thomson's paper) would be found to occur after the iron bars had reached a red heat, but which *has not yet* been verified by experiment.

I venture to express the opinion that the newer development of theory is fundamentally unsound. Maxwell, its originator, has been credited with having successfully reduced all electric and electro-magnetic phenomena to stresses of the ethereal jelly; in other words, to stresses of a hypothetical entity, of whose existence there is no *real* proof, and therefore the ultimate basis of the newer theory is hypothesis pure and simple.*

I cannot help thinking that some of our mathematicians would do well to take to heart the story handed down in reference to Archimedes. Archimedes undertook to move the earth, if only a base outside it were given him; the base he required was not forthcoming; that being so, we may be very sure he never wasted his time attempting to move the earth. Mathematicians, be they ever so able, can no more build up sound theory without an absolutely sound basis, than Archimedes, in the absence of a base, could move the earth. At the risk of being considered dogmatic, I venture to go further than this, and to express the opinion that the basis of all man's theories must be a material one, that is to say, the basis of theory must consist of direct observations associated with matter. We know just a little about matter and the forces associated with it, and no more, and what we do know has been learned from observation. Sir Isaac Newton never attempted to define gravity, he simply observed gravity's laws, the dogmatic utterances of Nature, and these utterances, *not* hypothesis, gave him a basis *absolutely* sound, which his mathematical ability was able to turn to splendid account. The great work associated with Joule rests ultimately on direct observation, and the same can be said of the mechanical theory of heat, whose basis was the observation, that when atmospheric air or other gas performed work in the act of expanding heat disappeared. No man can explain why this is so; it is simply a dogmatic utterance, and the ultimate basis of all true science consists of the dogmatic utterances of

* If any physicist could have evolved a true hypothesis, it will be generally admitted that Maxwell could have done so, but it passes the wit of any man to do this; the writer has a lively remembrance of the only time he had the pleasure of meeting Maxwell and discussing magnetism with him; had the writer not been aware he was speaking with the great physicist, Maxwell's large dreamy eyes and general physiogomy would have suggested the poet rather than the mathematician. With regard to the existence of the hypothetical medium, ether, the writer admits the necessity of some such assumption. As far as observation goes, no communication between matter and matter can occur, excepting through a medium, and such medium, as far as can be seen, must be of the nature of a material one. Energy, when associated with electricity, requires a path, and evidence is forthcoming which seems to necessitate a medium of some kind for magnetism to be transmitted; that being so, it seems a fair inference that a vehicle is necessary for the transmission of energy; in any case, our imperfect knowledge renders such an assumption almost a necessity; but if an attempt be made to define the nature of the medium which has to be mentally conceived, it will be found that the medium must be assumed to possess both positive and negative qualities at one and the same time, and such a conception makes as large a demand on our credulity as the Athenasian Creed itself. As we cannot altogether dispense with mental assumptions, it is legitimate enough to avail ourselves of them; but the writer's contention is that it should never be lost sight that they are mere assumptions, which cannot possibly form a base on which a scientific structure can be safely reared.

C

Nature, which we become acquainted with only by observing. The human intellect is very limited. It is equal to observing and building up observations, but it *cannot* create; and it does not seem capable of travelling, with safety, outside the limits of matter; and further, all science, if only completely grasped, can be explained by *common sense reasoning*, which, unfortunately, school training has a tendency to cripple.

If anyone will perform the task of carefully going through "Modern Views of Electricity," which is not the easiest of reading, he will find the newer development of theory to consist of a series of hypotheses, resting upon one another, and resting ultimately on hypothesis also, and every one of these hypotheses is taken for granted as being absolutely true.

Sir William Thomson, addressing a body of engineers as their President, not only told them that electric alternations were confined to the outer skin of a conductor, but he told them the actual depth they would enter under conditions he specified; in this address Sir William overlooked altogether the transformation of energy into magnetism, and its subsequent transformation into current during the demagnetisation which occurs between each alternation. I have pointed out in my articles that the current produced by the demagnetisation of a conductor is developed throughout the whole section, and is at a somewhat higher potential in the centre, and if I be right in my contention that transient currents pass through the mass of the conductor, then the energy transformed into magnetism and subsequently into current, whenever rapid alternations are transmitted, must represent a very considerable percentage of the energy.

Sir William Thomson cannot deny that the currents produced during the act of demagnetisation of an electric circuit are developed throughout the mass of the conductor; but according to the newer theory, there would be but little transformation of energy into magnetism, and, possibly, Thomson regards the current so produced as a negligible quantity, and considers that what transformation occurs between each alternation is covered by the term hysteresis. I am very sorry the word hysteresis has come into common use; I believe the term is due to Prof. Ewing, for whom I have the greatest respect, and to whom I have the best of reasons for feeling indebted. My reasons for objecting to the coining of terms is that they are too often employed to cover up problems, and to decently bury what ought to be faced. I do not want to claim more than I have a right to; but I think I have given a generally correct explanation of what occurs in a conductor when rapid alternations are being transmitted, and which the term hysteresis, as I understand it, covers, but does not attempt to explain; in any case, I have discussed the matter, and that is something.

A Leyden jar discharge through a metallic conductor is undoubtedly the most transient electric current we are familiar with, and therefore inertia phenomena should be accentuated in the highest degree when a Leyden jar discharge takes place through a metallic path. Now, I should like to ask Sir William Thomsom: (1) What evidence he can produce that the transient current of a Leyden jar discharge through a conductor of large section is confined to the outer skin? (2) What evidence is there forthcoming which goes to show that electric alternations transmitted by a transformer through solid cylindric iron bars are crowded into the outer skin.

I do not think (1) that it can be a matter of contention that in the alternative path experiments the B spark arises out of the demagnetisation of the path, L; (2) that the recorded observations of Prof. Lodge demonstrate that the discharge of a Leyden jar is completed in a less time through a No. 1 B.W.G. copper wire than through a No. 19 copper wire, the section of which is 100 times less than that of a No. 1 B.W.G. wire; (3) that the B spark is greater with the No. 1 wire than with a No. 19 wire; (4) that the spark at B, being due to current developed by demagnetisation, the greater spark observed in the case of the thicker wire indicates a greater transformation of energy into magnetism at the time of discharge, and this must be taken as demonstrating that the discharge passed through a larger mass of matter, for it seems clearly evident that if the discharge were confined to the outer skin of the conductor only, it would pass through a a thinner skin in the case of the larger conductor on account of its greater surface, and the spark at B would have been less, instead of being greater, as it was found to be by Prof. Lodge.

The alternative path experiments of Prof. Lodge—explained as they are, without any straining, by my simple theory—seem to me to prove my contention up to the very hilt.

Prof. Lodge cannot possibly object to his own experiments, and I assume Sir William Thomson accepts the recorded observations of Prof. Lodge in connection with these experiments. Now I should like to ask Prof. Lodge, and also Sir William Thomson, whether I have not made a fair analysis of the "alternative path" experiments; and I would further ask these two distinguished physicists, who have assumed responsibility in respect to the newer development of theory, on public grounds, not to maintain silence. I do not like to think that either Sir William Thomson or Prof. Lodge can have any other desire than the development of scientific truth; and I ask them, therefore, to meet me frankly and straightforwardly. My main contentions are plain enough, and admit of plain answers; and I do hope, if I am honoured by criticism, such criticism will not be confined to the outer skin of my arguments.

STENO-TELEGRAPHY.

UNDER the name of steno-telegraphy, Mr. G. A. Cassagnes designates a new telegraphic system, founded on the combination of mechanical stenography with telegraphy.

The apparatus is an adaptation of the stenographic machine of Michela in which, by means of 20 signs and their combinations, all possible phonetic sounds can be represented. As soon as spoken, the words are, so to say, decomposed by the ear of the operator at the key-board; the graphic representation of syllables is printed in small distinct lines on a tape of paper, and there only remains afterwards to read these lines from left to right to reproduce the language spoken, whatever it be. It is stated that an operator can, after about six months' practice, stenograph from 150 to 200 words per minute in a language with which he is familiar, which is more than is necessary to follow the fastest speaker. Fifteen days are said to be sufficient to learn to read the tape fluently.

M. Cassagnes's invention has for its object to reproduce at a distant station the stenographic tape that Michela's machine produces, *in loco*, and at the same speed. The object is effected with a single wire and an arrangement of the multiplex system in which the La Cour phonic wheel plays such an important part, the La Cour method of synchronism being adopted.

The distributor with its trailing arm has 20 sectors, or groups of sectors, each corresponding to one of the 20 signs referred to.

A large number of practical experiments have been made with the apparatus on looped wires (properly arranged with earth connections), and also on direct wires with the instruments at the ends of the wires between Paris and Lille, the route followed being circuitous, and the greatest length 770 kilometres. In all cases the results are stated to have been most successful, the output of work being very much greater than that obtained on the ordinary telegraphic system.

We must remark, however, that with the apparatus arranged to work as an automatic system, *i.e.*, using perforated tapes, the maximum speed appears to have been 400 words a minute which is quite equalled in this country by the Wheatstone automatic system, with its less complicated mechanism.

ELECTRICAL ENGINEERS AT EDINBURGH.

ABOUT 70 members of the Institution met in the phonograph room of the Exhibition on Tuesday last to hear papers read. Dr. Hopkinson, in his capacity as Chairman, expressed satisfaction at seeing a good number of members present to enjoy the kind hospitality of the Executive Committee of the Exhibition.

At the commencement of the business the secretary announced that Sir Archibald Campbell would be pleased to see any members of the Institution at his works on the Clyde. Several gentlemen of Edinburgh were also anxious to receive members of the Institution as guests, an anxiety which would doubtless be relieved.

Dr. Walmsley read a paper on some of the chief features of the Exhibition, a subject exhaustively treated in the pages of the REVIEW. Mr. Bennett followed with a paper on "Foreign Currents in Telegraph and Telephone Lines."

In the evening the Executive Council gave their reception in the Concert Hall to the members. Several articles and scientific instruments were specially exhibited.

The meetings were resumed on Wednesday morning, Mr. W. H. Preece in the chair. The paper on "The Working Efficiency of Secondary Cells," was, in the absence of Prof. Ayrton, read by Mr. Lamb, one of the joint authors. A discussion followed, which we shall publish at the end of the paper, which we partly produce in this issue of the REVIEW.

After the reading of the papers, a party of the engineers and friends left in the afternoon for Queensferry, to view the Forth Bridge. The male portion alighted from the train at north end and walked over the bridge. Reaching the other side a launch was chartered which conveyed the whole party under and about the bridge. It is needless to say, the structure was generally admired.

THE TELEGRAPH CLERKS AND THE NEW SCHEME.

WITH a praiseworthy alacrity which has probably astonished even their best friends, and which is generally considered foreign to the deliberations of that administrative body, the Lords of the Treasury have considered, sanctioned, and returned to the Postmaster-General the recommendations submitted to them by him, and which have for their object the general improvement of the position and prospects of telegraph clerks in the service of the Crown.

The provincial readjustment has, it is stated, given satisfaction in various quarters; but it would be premature to judge of the general feeling at so early a period, more especially as its application has yet to be effected. We may, therefore, take the reported provincial approval as being at present largely prospective. Dealing with the proposals which immediately concern the numerous and ever-increasing staff at the Central Telegraph Department, London, we find that the Postmaster General's offspring has been presented to them without a head. This has probably got knocked off, or, as the official phrase has it, been "delayed in transmission"—whether designedly or not, we cannot say. But the fact remains, and, to put it in a simple way, it is a column lacking its most interesting and characteristic feature—namely, its capital.

We cannot but admire, as we are sure all telegraph clerks will appreciate, the thoughtful, considerate, and, we feel inclined to add, generous spirit with which the base and trunk of the Postmaster-General's work have been invested.

In this direction we observe that where leave cannotbe granted on Bank Holidays, extra pay will be awarded. The official intimation of this, as of several other points in the scheme, is vague and ambiguous to a degree. This may be due to hasty drafting, together with a desire to give immediate information to the staff; at all events, it is to be hoped that it has not been intended as a suitable adjunct to the missing "capital," to which we will refer more fully hereafter.

The ambiguity of this document is probably also the cause of the more important announcements contained therein being received with, as we hear they have been, dissatisfaction and distrust.

Another generous concession, and one for which telegraph clerks will not fail to heartily thank the Postmaster-General, is that all overtime shall be paid for at what is known as "rate and a quarter." Knowing as we do that through a heavy—nay, almost a necessitous and often unforeseen—demand on the one hand, and, generally speaking, a ready response on the other, much extra time has to be performed, we cheerfully recognise both "just and generous" consideration here. This, and the Bank Holiday arrangement, will be common to the whole service.

Provincial clerks will be paid overtime for Sunday work, an emolument always given to London men. In a somewhat uncertain manner it is stated that annual leave will remain as before, and we accept this as meaning that clerks receiving £150 per annum and upwards will receive one calendar month's leave.

There is a reasonable possibility that clerks, in a scale which extends to £160, are entitled to the same period.

The leading features of the scheme, however, are the monetary reforms.

Clerks in the second class will, after a period of probation, say, about two years, go from £45 or £46, by £6 per annum, to £110—old maximum £100, by £5—£110 after 14 years' service; certainly not a dazzling prospect! 1st class, £110 to £160, by £6, an increase of £20 on old maximum. We find that a first-class clerk will have served 22 years and upwards for this sum, unless in the earlier stage some encouragement, in the shape of double increments, is forthcoming. We do not think him likely to appreciate his position, and for reasons which will require little explaining.

We have already said that the Postmaster-General's column lacks its capital. The official announcement refrains from holding out any prospect whatever as to a first-class clerk's promotion to the senior class. The case of the senior class, as at present constituted, is under consideration, and the most adverse rumours are in circulation. Many first-class clerks, who have been told that they are "worthy of every encouragement," have already been waiting two, and in some cases, nearly three years at the top of their class at £140. They have seen colleagues with no more, and a few with considerably less service promoted to the next or senior class. These latter will attain Mr. Fawcett's maximum of £190. The former, who had been contemporary with them, through being what is officially termed "unlucky," will, after 25 years' service and upwards, find themselves in receipt of £160, and with absolutely no prospect beyond that figure held out to them. The Postmaster-General's decision with reference to the scheme is the "capital" to the "column." His decision being withheld, though even briefly, robs his labours of what should be their crowning glory. We can see here why the staff have a dislike to receiving schemes by instalments. It is to be hoped, in the interests of the public service and also of its servants in the Telegraph Department, that a fair and free prospect of at least attaining Mr. Fawcett's maximum of £190 or, better still, £200, will be given to all meritorious and deserving men.

As we have already said, much in the Postmaster-General's scheme commands our unqualified praise, and we recognise therein consideration and even sympathy for the more ordinary privileges and comforts of the telegraph clerks as a working body both in the concrete and the abstract.

The delay in dealing with what we have termed the "capital" question will be happily incurred, provided it results in what we trust will be a just and liberal

recognition of the claims of the hundreds upon hundreds of telegraph clerks who are anxiously and earnestly awaiting the creation of what is commonly known as a "reasonable prospect." Such a step would, we feel assured, set the seal to the Postmaster-General's work, his reward would be found in the spread of a gradual, yet, nevertheless, general and abiding contentment throughout the service, agitation would have only one object—to languish and die—the lack of cheers and excess of jeers of which we have heard far too much on recent occasions—as we have also of the "violent assault" case, to which we merely refer, and which has, we imagine, been distorted and exaggerated beyond all reason—would give place to a hearty and earnest union of interests, tending to the advantage and satisfaction of the public, and the commercial success and progress of the telegraph service, throughout the country.

NOTES.

Newry and the Light.—The Town Commissioners have refused their consent to the application of the Irish House-to-House Electric Light Company to light the city.

Sheffield Lighting.—A special meeting of the Town Council has been called to consider applications by electric lighting companies. The *Sheffield Independent* suggests that the council should itself apply for powers.

Weymouth Lighting.—Messrs. Latimer Clark, Muirhead & Co., London, intend to apply to the Board of Trade in the next session of Parliament for a provisional order to supply electricity in the town.

Proposed Electric Lighting at Worthing.—The Laing, Wharton and Down Construction Syndicate, Limited, notify their intention of applying for a provisional order enabling them to supply the electric light within the jurisdiction of the Corporation of Worthing. The local authority has referred the subject to a committee, who will recommend whether the application shall be assented to or opposed.

Competitive Electric Lighting at Southampton.—Several companies are in the field anxious to obtain the necessary orders to enable them to supply the electric light within the Borough of Southampton, among them the South of England House-to-House Electricity Company, the Electric Installation and Maintenance Company, the Southampton Electric Light and Power Company, and the National Electric Supply Company. The Town Clerk has written to these rival companies informing them that it was not at all probable that the Corporation would assent to their applications; and the House-to-House Company has replied that in the event of the Corporation deciding to undertake the supply of the electric light, it would not proceed with its provisional order, but offer the Corporation every assistance.

Electric Lighting at Brighton.—At a special meeting of the Brighton Town Council on Thursday, contracts for the erection of buildings for an electric light generating station and for other works, were ordered to be entered into forthwith. Alderman Ewart said that the electric lighting scheme was the beginning of an enterprise which would make Brighton more popular than ever. The sooner every hotel, lodging house, and the important thoroughfares were lighted by electricity, the better it would be for the town.

Pertinent questions are being asked with reference to the tenders for supplying the electrical plant in Brighton. In one instance, that of dynamos, the highest tender was £11,946, and the lowest £6,975. Why this difference queried Col. Tester? It is also suggested that the successful contractors were unduly favoured by the Lighting Committee's engineer.

Exeter and the Electric Light.—There was a discussion at the last meeting of the Exeter Town Council, anent the desirability of the corporation undertaking to supply the "light of the future" to the inhabitants, instead of allowing private companies to establish a monopoly in the city. The Devonshire Electric Light and Power Supply Company, Limited, has given notice of its intention to apply for a provisional order, and in view of this, it was decided to appoint a committee to consider the desirability of the corporation taking steps to obtain the necessary electric lighting powers.

Berlin Lighting.—Notwithstanding the satisfactory arc lighting in the Kaiser Wilhelmstrasse and the Unter den Linden, it is not, says the *Electrotechische Echo*, intended to extend the public electric lighting for the reason that the perfection of gas lighting produced by competition is expected to give the same result with less cost.

The Lighting of Dusseldorf.—A central electric station proposed for the town was to have had a capacity of 10,500 lamps of 16 candle-power, but owing to the demand it is decided to enlarge the scheme to a capacity of 18,000 lamps, and new tenders are invited. Most of the tenders sent in were for continuous current with accumulators.

Woolwich Lighting.—The Woolwich Electric Company and the London Electric Supply Corporation have both notified to the Woolwich Local Board of Health their intention of applying to the Board of Trade for provisional orders to light Woolwich by electricity. A special day is to be devoted to consider the applications. There appears a disposition amongst the members of the board to favour the local company.

Canterbury Lighting.—By a majority of one the Canterbury Corporation has resolved that pending the granting and confirmation of the provisional order to be applied for by the council, application be made to the Board of Trade, authorising the council to supply electricity for public and private purposes within the city. If the licence be granted, it is proposed to commence operations at once.

Electric Light at Bridlington.—The Laing, Wharton and Down Construction Syndicate has fitted up the Prince's Parade at Bridlington with 1,200 candle-power arc lights. The lamps were working for the first time on Saturday last before a gay and fashionable assemblage.

Croydon Lighting.—The Corporation of Croydon has decided to apply for parliamentary powers, with the intention of selling its rights or not, as it pleases, to a company.

Leamington Lighting.—The worthy folks of Leamington still appear to have a very bad impression of the electric light, Mr. Crowther Davies, at a council meeting, characterising it as "eminently unsatisfactory."

Winchester Lighting.—Tenders are invited for lighting the city and municipal buildings by electricity.

Breaking Telephone Insulators.—Six Birmingham boys have been fined 5s. each for damaging wires and insulators belonging to the National Telephone Company at Smethwick. About 150 insulators were broken, and serious interruption caused to the service. Over 12,000 insulators had already been broken in this way.

Sensational Reporting.—In describing an accident at the Californian Electric Light Company's Works, a San Franciscan reporter states that "the volts (big fellows, weighing 20 lbs. each) whizzed through the air with the velocity of cannon balls, and buried themselves in the walls of the establishment. One man was injured, though not seriously." A New York exchange suggests that he may have been hit by one of the flying volts.

Laying of the Tory Island Telegraph Cable.—On the evening of Wednesday, the 9th inst., at 7.30 p.m., the opposite ends of the telegraph cable between Tory Island and Pollaguill, on the mainland, were brought together and united. From that moment the long-talked of project of telegraph communication between Tory Island and the mainland had become a reality, and the "Sentinel of the Atlantic" is now connected by telegraph with every shipping office in the British Isles. The contractors with Lloyd's for this work are the India-Rubber, Gutta-Percha and Telegraph Works Company, of Silvertown, London. The steamer *Buccaneer* was in charge of Captain D. Wilson Barker, R.N.R., the expedition being under the direction of W. H. Gray, Esq., engineer-in-charge, with Mr. Edward Stallibrass, assistant engineer, and Mr. J. Schneider, electrician. The cable is one of special construction. The shore end extends about a mile at each end, and weighs 17 tons to the mile. It has two cores and two sheathings of galvanised wire, with an outside protection of hemp cords and bituminous compound. The cores are protected against insects by brass tape. The main or deep-water cable weighs about 7½ tons per mile, and has but a single sheathing of wire. The underground or Tory Island end of the cable weighs about two tons to the mile, has one sheathing of galvanised wire, and has a protection of tarred cotton tape. In order to inform passing ships of the telegraph line, and as a protection against vessels casting anchor over it, one large buoy is placed over the cable about a mile south of Tory, having on it the word "Telegraph" in conspicuous letters. Nothing remains but to complete the arrangements for laying the land-line on Tory. Full directions have been given by Mr. Gray to have this work accomplished, and an officer from the Post Office is also making preparations for the erection of poles and connecting the wire between Pollaguill and the telegraph office at Dunfanaghy. By the kind permission of Mr. Gray and Captain Barker, a number of ladies and gentlemen at Dunfanaghy eagerly availed themselves of the rare opportunity of witnessing these scientific experiments in electricity, and the practical routine pursued in laying deep-sea telegraph cables, and at the same time of seeing Tory Island, and while on board the *Buccaneer* the visitors were most hospitably entertained by the officers engaged in the expedition.

Tenders Wanted.—Tenders for the electric lighting of Stockholm are invited, the same to be sent to the Director of Gasworks, Stockholm, by September 1st. Particulars may be seen in our advertisement pages.

Electric Traction.—*Money*, in announcing the formation of two more electric traction companies, says that until the traction companies agree to work by electricity a good stretch of line, nothing but experimental and commercially unsuccessful short lines will result.

A Gaulard Monument.—A statue to the late M. Gaulard will be inaugurated in the course of the month at Lanza, Turin. Gaulard will be represented crowned with laurel and oak leaves, and at his feet will be sculptures in low relief, emblematical of his achievements in the domain of electricity and of his untimely death. The monument is by Cesare Biscarra, of Turin.

The Electric Welding Company.—The *Stock Exchange* understands that this company, when brought out, is likely to be attacked by the electrical papers on the ground of over-capitalisation. Our contemporary is not far out in its calculations.

Electric Traction in the States.—The Spring Garden Avenue Street Car Line, of Pittsburgh, is going to be turned into an electric road.

Personal. — We have received an intimation that Mr. John Pearce has commenced business as an electrical engineer at 182, West Regent Street, Glasgow.

Secondary Batteries.—The paper on "the Working Efficiency of Secondary Cells," by Messrs. Ayrton, Lamb, Smith and Woods, read at the Edinburgh meeting of the Institution of Electrical Engineers, contains much valuable information. There is little in the paper, however, which has not been said before, but it must be conceded that the authors have treated several important points in a most exhaustive manner, and they have furnished experimental proofs on certain phenomena concerning which much doubt has hitherto existed. We must congratulate Prof. Ayrton and his assistants upon the thorough manner in which the task has been performed.

The Central London Railway Bill.—The Committee of the House of Lords has decided that the preamble of this Bill "is not proved."

Wimbledon Lighting.—It appears that the Wimbledon ratepayers do not take kindly to a circular and accompanying form which Mr. Arthur Holland, chairman of the electric lighting committee, is sending to probable users. A letter in the Wallington *Herald*, of the 12th inst., from Mr. A. Ward, throws much light upon the matter.

The Old and the New.—The Old Hall, which now forms a portion of the works of Messrs. Clarke, Chapman & Co., of Newcastle, is the house described by Charlotte Brontë in her famous novel, "Jane Eyre." The place is now virtually the firm's lamp factory, and in the entrance there is fixed and in use what is said to be the largest incandescent lamp in existence.

Fire Office Rules.—Mr. John B. Verity writes as follows:—"I venture to trespass on your valuable space in reference to a matter which is engaging a considerable amount of attention amongst electrical contractors at the present time, viz., Fire Office Rules. Formerly most contractors carried out their work as nearly as possible in accordance with the Phœnix Rules, but now every fire office has a special set of rules for electric lighting on its own account. This was, of course, to be expected, as competition among insurance offices is as keen as in any other business. What is the electrical contractor to do? In an important installation the building and contents are often insured in three or four leading offices, all of whom ask if the work has been carried out in accordance with their particular rules; and how can this possibly be done when the rules vary in important respects? It seems to me that the sole remedy is for the electrical contractor to work carefully in accordance with the rules laid down by the Institution of Electrical Engineers. If these rules are considered insufficient in any particular respects, contractors will soon hear of it, and where there is any consensus of opinion, a report should be made to the Institution, and a periodical revision of the rules undertaken by a committee. This, I believe, would do away with the present hopeless condition of affairs, when a surveyor from one leading office expresses great satisfaction with work one day, and the next day a surveyor from another equally important office swoops down and harasses the contractor by demanding alterations which can best be described by F.A.D. in capitals."

Edinburgh Tramways.—The question as to the future management of these tramways is beginning to arouse public interest. We may yet possibly see electric traction advocated.

Connoisseurs from Bristol.—The Bristol Electric Light Committee has been prowling about in the small hours of the morning, under the guidance of Mr. Preece. Several stations, including Brompton, Sardinia Street, Manchester Square, and Deptford were visited, and Mr. Preece's house was eventually invaded, the committee leaving town with the impression that electric lighting is, at the best, 25 per cent dearer than gas.

Lighting Newspaper Offices.—The offices of the *Sportsman*, in all departments, have been fitted with the electric light, in a manner most satisfactory to the proprietors of that journal, by Messrs. Arthur B. Gill and Co.

A New Insulator.—The Kinetic Engineering Company sends us the following :—"With reference to the paragraph in your last issue upon what is termed a new type of Berthoud-Borel cable, kindly permit me to say that not only has no such type of cable ever been manufactured by the Berthoud-Borel factory, but that no one connected therewith would ever dream of using such substances as celluloid or tarred hemp for the purpose of cable insulation."

The Bermuda Cable.—A New York telegram of last Friday states that communication by submarine cable between the Bermudas and Nova Scotia has been satisfactorily established. The first cablegrams were interchanged between Halifax and the Bermuda station the previous day.

The Halifax and Bermudas Cable Company.—The following is a copy of a telegram received by the chairman from the Governor of Bermuda :—"The Chairman of the Halifax and Bermudas Cable Company, London—Many thanks for your message. I warmly congratulate the company on the successful laying of their cable, and sincerely wish them every prosperity. —NEWDEGATE, Governor, Bermuda.

Telephonic Communication between London and Provinces.—Last Friday afternoon a wire to London, which was ompleted late the previous night, was tested at the offices of the National Telephone Company, Faulkner Street, Manchester. Alderman Thompson, who was attending a meeting of the directors of the company at the Cannon Street Hotel, in London, and other gentlemen held conversations with representatives of the Press and others in Manchester, and not only were the words uttered heard quite clearly, but the tones of each voice were recognisable. The new wire, we understand, extends from Sheffield to London, and terminates at the office of the company, Oxford Court, Cannon Street. There is already existing a wire from Sheffield to Manchester, and the two wires were placed in circuit. The gentlemen at the offices of the company in Faulkner Street, Manchester, were thus enabled, with the most perfect ease, to speak to officers of the company in London. Colonel R. R. Jackson, one of the vice-presidents of the company, was one of the gentlemen in London who conversed with representatives of the Press in Manchester. London to Manchester is 221 miles ; to Liverpool *viâ* Manchester, 266 miles ; to Sheffield, 195 miles ; to Bradford, 252 miles ; to York, 275 miles ; and to Leeds, 252 miles. It is expected that in the course of a fortnight the London wire will be available for the use of the members of the Exchange in Manchester. Telephonic communication between London and Liverpool was also established last week. Messages were first exchanged between the Mayor of Liverpool and London, and during the afternoon several commercial messages were transmitted. The opinion of those who tested the telephone was that, though 200 miles separate, London and Liverpool messages will be as distinctly heard as if they were transmitted between the local centres.

Fatal Accident at Blackpool.—A little boy was last week knocked down by an electric tramcar while crossing the promenade near the Foxhall Hotel, Blackpool, and received such injuries that death resulted almost immediately. The driver of the tramcar was not to blame. The roadway is very narrow at that point, and the little fellow was in front of the car before it could be stopped.

Telegram Paper.—A firm of London estate agents bitterly complains of the flimsy pink paper supplied recently for telegrams. For several cogent reasons a change for the better is suggested, in which we entirely concur.

The Telephone in Italy.—Telephonic communication is to be established between Rome and Naples, Florence, Genoa, Turin, Milan, Venice, Spezzia, as well as between Turin and Milan, Milan and Venice, Genoa and Turin, Genoa and Florence, Naples and Palermo, and Messina and Palermo.

Earthquake Shocks and Telegraphic Cables.—The Eastern Extension Company has had to notify the interruptions of telegraphic communication with Australia by the sudden and simultaneous breakage, on the morning of the 11th, of their three cables between Java and Australia, presumably by earthquake, as shortly before the interruption a shock, said to be the sharpest felt for many years in the neighbourhood, passed over Bangoewangie, at the eastern end of Java, close to which all three breakages occurred. Restoration of communication was expected in about a week's time.

The Electric Light at Woking.—The laying of mains for the supply of electric current for illuminating purposes is now proceeding, the mains having been laid underground as far as the railway arch on Goldsworth Road. Everything is expected to be in readiness by the 1st October, and experimental lighting is to take place before that date. A meeting of ratepayers of the parish is to be convened at an early date to take into consideration the desirability of publicly lighting Woking Station district.

Mahla's Carbons.—Messrs. Cathcart and Peto have been appointed sole agents in the United Kingdom for the sale of Mahla's electric light carbons. In addition to excellence of quality, unusual whiteness of light and great efficiency is specially claimed for these carbons.

The Whitehall Club.—A very good and representative meeting of the electrical members of the Whitehall Club met at dinner on Thursday evening, last week, Dr. Hopkinson presiding. The general feeling of the gentlemen present, who, with a few guests, numbered about 30, was distinctly against anything approaching cliquism, and we imagine that those who have joined the club will simply act their parts as ordinary members without any reference to representing an electrical section of the engineering profession. Messrs. Albright, Sellon and Killingworth Hedges may be congratulated on having secured the subscriptions of a larger number of gentlemen than was actually requisite to meet the concession of the committee, and to participate in the privileges of becoming members of the Whitehall Club.

Kilmarnock Chemical and Electric Works.—Messrs. J. and J. Blair intimate that they have added to their business a department of electrical and mechanical engineering, which will be under the immediate superintendence of Mr. James Campbell, late of Anderson, Campbell & Munro, Limited, Hyde Park Electric Works, Glasgow.

The Compound Winding Case—Judgment Sustained.—The first judgment in the compound winding suit between Messrs. King, Brown & Co., of Edinburgh, and the Anglo-American Brush Corporation, has been sustained in the appeal case. We shall give the complete text of the decision in our next ; but append hereto the precise words of the Judge :—"I am of opinion that the interlocutor of the Lord Ordinary should be adhered to, and decree of reduction of patent pronounced." (The Lord President.) That is the opinion of the Court. On the motion of Mr. Daniell, counsel for Messrs. King, Brown and Company, the Brush Corporation was found liable in expenses.

The Electric Light at Weybridge.—At last week's meeting of the Chertsey Rural Sanitary Authority, notice was received from the Laing, Wharton and Down Electrical Construction Syndicate, Limited, that they intend to apply to the Board of Trade for a provisional order for the lighting of Weybridge under the Electric Lighting Acts. The clerk was directed to give special notice that the subject would be considered at the next meeting of the Authority, on August 19th.

Incandescence Lamps.—The Brush Electrical Engineering Company, Limited, has acquired the Edison lamp patents for Australasia, India, the Cape of Good Hope, and Natal, and notifies that it is an infringement of the rights now secured by assignment to that company to import, sell, manufacture, or use any incandescence electric lamps in those colonies except under licence from the company. While the Brush Electrical Engineering Company is resolved to assert and to maintain its rights, it will supply incandescence lamps at prices not higher than those which now generally prevail in the colonies.

Fast Telegraphy.—We print elsewhere a brief description of the steno-telegraph, a system devised by M. Cassagnes for dealing quickly with a large quantity of telegraph work. In a report by a M. Despeissis on the system, it is stated that steno-telegraphy gives one of the most practical solutions to the problem which has to be faced to-day more than ever, by all telegraphic administrations, viz., the clearing up of their wires. It would seem that the writer is ignorant, not perhaps of the Wheatstone automatic system, but of the *capabilities* of that system as worked in this country, for satisfactory as the steno system is stated to be, it is certainly quite equalled by the Wheatstone when properly manipulated.

An Electrical Effect.—A correspondent, writing to *Nature*, draws attention to a simple experiment which is an interesting variation on the ordinary mode of performing the experiment of putting pieces of zinc and silver in the mouth and touching them, to obtain the acid taste which accompanies the completion of the electric circuit. If the piece of zinc be placed under the tongue, and a florin vertically between the upper lip and the top row of teeth, and the two metals be brought in contact, a faint flash is seen in both eyes when the eyes are open. If the eyes are shut the sensation of light is not felt, so that the effect is probably due to a muscular twitching. It is necessary to use a large silver coin, and not a shilling, and to push it well home behind the upper lip. We are under the impression that this effect is mentioned by Tyndall in his "Electricity," and that the effect is stated to be due to the electric action on the optic nerve.

The Villard Syndicate.—A Milwaukee despatch says:—"The three principal street railways of Milwaukee are to be consolidated, under control of the Villard Electric Syndicate. Bonds covering all three properties, the Becker line, the Milwaukee, and the Cream City, are to be issued in place of those now outstanding. About $2,000,000 new stock and bonds are to be issued. Villard people acquire 50 miles of double track by equipping electrically and taking securities in return." According to another:—"A deal involving upward of $5,000,000 and including a transfer of a controlling interest in the Badger Electric Light Company, the Edison Light Company, and the Cream City and Milwaukee Street Car Companies, is said in the American papers to have practically been consummated. The purchaser is the so-called Villard syndicate, including Henry Villard and Ryan, the Pittsburg capitalist. But Milwaukee capitalists will still retain an interest in each of the corporations, although there is a complete change of owners in the Badger Electric Light plant. The purchasers outside of the Villard syndicate are the same Milwaukee men who are interested in the Edison Electric Light plant now being built."

Private Central Electric Lighting Stations.—It is perhaps a little surprising that so little has been done in the way of private central electric lighting stations; the cause of this has no doubt been due to the very indefinite information which is to be obtained with reference to the economy of the electric lighting system; this, of course, makes householders hesitate before they commit themselves to a plan which may prove unexpectedly expensive, and, they also probably think, troublesome. Far and wide as the electric light is spreading, its advantages are still very far from being understood, and it still requires to be forced into notice. In one or two cases private central stations have been successfully started, and notably at Kirkton Hill, Dumbarton, where Mr. Denny, whose own residence has been lighted for some years by a separate plant, has induced a number of householders to have their houses electrically lighted. Some precise facts as to expense with reference to this and similar plants would be highly useful.

Deaths from Electric Currents.—A correspondence between the Foreign Office and the Board of Trade, with reference to deaths from electric currents in the United States, has just been issued as a Parliamentary paper. It appears that the United States Census Office is not at present in possession of the *data* necessary to enable it to furnish the information desired, but the New York municipal authorities state that from January 1st, 1887, to May 15th, 1890, there were 16 deaths from electricity in that city. The Foreign Office and the Board of Trade might have consulted the ELECTRICAL REVIEW with advantage.

The French Telephones and the State.—The taking over of the French telephones by the State is leading to heavy outlay, and consequent discussion in the Chambers. Two supplementary credits are now asked for, one for 3,500,000 francs, and another of 1,629,622 francs, by the Ministry of Commerce, in order "to face the expenses of putting in order and extending the telephone lines."

The Board of Trade Regulations.—The electric lighting companies, says the *Financial Times* of Tuesday, have still a good deal to contend with at the hands of the Board of Trade. The report of Crompton and Company, Limited, thriving purveyors of electric light, mentions that a contract to light the town of Chelmsford has not been profitable, having "cost more than the original estimate, largely in consequence of unexpected and difficult requirements of the Board of Trade." "It is to be hoped that in the interests of science, of the great sum of capital invested in electric lighting companies, and of the public generally, this Chelmsford incident may be explained and thrashed out at the Crompton meeting next Monday." Perhaps our article on "State Control" may be the means of giving a helping hand to this end.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Dermatine Company, Limited.—The statutory return of this company, made up to the 8th August, 1889, was filed on the 27th ult. The nominal capital is £550,000 in £5 shares. 6,152 shares are taken up, and 7s. 6d. per share has been called thereon, £26,760 2s. 6d. is considered as paid upon 6,152 shares. The calls paid amount to £2,152 2s. 6d., and unpaid to £154 17s. 6d.

Mutual Telephone Company, Limited.—The statutory return of this company, made up to the 17th ult., was filed on the 8th inst. The nominal capital is £45,000 in £10 shares, 12 shares have been taken up, and £1 per share has been called and paid thereon. Registered office, 10, Tokenhouse Yard.

Trent Gas Engine Company, Limited (Gas Engineers and Electricians).—The statutory return of this company, made up to the 24th ult., was filed on the 28th ult. The nominal capital is £15,000, divided into 750 preference and 750 ordinary shares of £10 each. The shares taken up are 555 preference and 750 ordinary, 300 of the former and 750 of the latter being considered as paid up. Upon 255 preference shares, £7 10*s.* per share has been called, the calls paid amounting to £1,912 10*s.* Registered office, 38, Duke Street, New Basford, Nottingham.

Archer Pipe Company, Limited (Pipes and tubes for electric light, telephone, and other wires, &c.)—The statutory return of this company was filed on the 5th ult. The nominal capital is £10,000 in £1 shares. 8,672 shares are taken up, and of these 5,000 are considered fully paid. Upon 3,672 shares, the full amount has been called, the calls paid amounting to £3,467, and unpaid to £205.

LEGAL.

In re Northern Electric Wire and Cable Company, Limited.—Chancery Division (before Mr. Justice Kay). This was a motion on behalf of Mr. Edward W. Hall, asking that the register of the company might be rectified by removing his name from the list of shareholders in respect of 160 £5 shares, and that his deposit money might be returned. Mr. Justice Kay said the facts were these:—On June 25th, 1889, the company was incorporated. Under the articles the subscribers to the memorandum were to be the temporary directors, until directors had been regularly appointed by the subscribers, or a majority of them. At 10.30 a.m. on June 25th, a meeting of the subscribers was held, at which four were present. A resolution was passed appointing directors, and also one allotting shares to different persons, amongst others, 160 shares to Mr. Hall. It was not until July 3rd that Mr. Hall applied for shares. On the 29th of July, another meeting was held, and the minutes of the previous meeting were passed. On the 14th of August, Hall told the secretary verbally that he would withdraw from the company. On the 23rd of August the secretary wrote a new letter of allotment. Upon this, Mr. Hall applied for a return of his deposit, but the directors in December forfeited his shares. Mr. Hall then brought this motion. In his Lordship's opinion there had been no allotment at all. There had been no application followed by an allotment, and a communication of that allotment to Mr. Hall; there had only been an allotment before application. The proceedings were most irregular, and the motion must be allowed, with costs.

CITY NOTES, REPORTS, MEETINGS, &c.

The Eastern Telegraph Company.

SIR JOHN PENDER, K.C.M.G., presided at the thirty-sixth half-yearly meeting of the shareholders, held at Winchester House on Thursday last, at 1 o'clock, when the following report, with the accounts for the half-year, was presented:—

The revenue for the period amounted to £424,023 14*s.* 3*d.*, from which are deducted £98,477 16*s.* 3*d.* for the ordinary expenses and £47,520 2*s.* 11*d.* for expenditure relating to repairs, renewals of cables, &c., during the half-year. After providing £2,943 10*s.* 7*d.* for income tax, there remains a balance of £275,082 4*s.* 6*d.*, to which is added £61,151 1*s.* 5*d.* brought from the preceding half-year, making a total available balance of £336,233 5*s.* 11*d.*

From this amount there have been paid:—Interest on debentures and debenture stock, £28,274 13*s.* 1*d.*; dividend on preference shares, £20,474 3*d.* 3*d.*; and an interim dividend of 1½ per cent. on the ordinary shares, £50,000; leaving a balance of £237,484 9*s.* 7*d.*, from which £125,000 has been carried to general reserve.

The directors now recommend the declaration of a final dividend for the year ended March 31st, 1890, of 2*s.* 6*d.* per share and a bonus of 3*s.* per share, amounting together to £110,000 both payable on the 18th inst., free of income tax, and making, with the three previous payments on account, a total distribution of 13*s.* per share or 6½ per cent. for the year on the ordinary shares. The balance of £2,484 9*s.* 7*d.* shown at the foot of the revenue account is proposed to be carried forward to the next half-year.

The revenue includes £74,337 8*s.* dividend and bonus for the half-year upon the company's investments in the Eastern and South African, the Black Sea, the Direct Spanish and the African Direct Telegraph Companies.

The convention referred to at the last general meeting between the French Government and this company, for the renewal of the agreement for the direct line through France, and the landing and working of submarine cables at the company's station at Marseilles, has since been ratified, and the agreement has been renewed between H.M Postmaster-General for a special wire by land line and cable connecting this line with London.

A convention has been entered into with the Italian Government for the prolongation for 20 years of the existing concessions, for the working and maintenance of submarine telegraph cables between Italy, Malta, Corfu and Egypt.

The directors have concluded an agreement with the Turkish Government for the laying of a short section of cable between the island of Perim and Sheikh Seyd, which will bring to this company's system the traffic from Hodeida Mocha, and other points on the coast of Arabia now being connected by the Turkish Government with their system of land lines to Jeddah.

The International Telegraph Conference has been held in Paris, at which the chairman, managing director, and other representatives of the company attended. The interests of the company were carefully watched, and the result has been on the whole not unsatisfactory.

Sundry reductions in the Continental tariffs were made, to come into operation in July, 1891, which will affect the company's revenue to a moderate extent, but the directors hope that the increase of traffic will eventually recoup the loss.

Negotiations of an important character are being carried on between the Eastern Extension Company and the Australasian Colonies, with a view to effecting a large reduction in the tariff to Australasia. This company is interested in these negotiations in so far as it will take a part of the risk, trusting that the reduction of tariff will tend to a large increase of traffic, and it is believed that these negotiations will speedily be brought to a satisfactory conclusion.

The several sections of the company's cables are in good working order, with the exception of the original Red Sea cable, which connects Suakim with Suez and the Island of Perim. The frequent interruptions of this cable taken in connection with the prospect of increased traffic to Australia necessitates the laying of an additional cable in the Red Sea, from Suez to Aden, which the directors expect to have completed and in working order before the end of this year. The cost of this will be taken mainly from the reserve fund.

The Chairman, after explaining some items of the account, said:—On the last occasion he referred to the West Coast system as being fully completed, and that important results might be expected from it. He was now glad to confirm that opinion. One of their sections, the African Direct, was now paying 4 per cent., and he hoped in another year would see an increase upon that. The West African Company was paying a 5 per cent. dividend, and, if the state of things which had existed in Africa continued, they might also expect an increase in that quarter. Altogether they were in a position to meet all requirements which might arise in the development of the "Dark Continent." The company was prepared to do its part in connecting that new world with the old. The trouble which the company had receutly experienced in Egypt had given place to a better state of things there, very much to the company's benefit. Its relations with Egypt were in fact most satisfactory. As regards the Telegraphic Conference, its attitude had been on the whole very fair to the cable companies, and this company's relations with European governments had never stood higher. It had had to submit to certain reductions in the interest of Spain, Portugal and Gibraltar, but he anticipated that these reductions would be compensated for by increased business. The company's relations with India were very materially improved at the conference. He further said that he had received a letter from a prominent shareholder, who, after complimenting the management generally, said that, looking to the large sum carried forward, a larger bonus ought to have been declared. He, the chairman, observed, with regard to that, that the company was party to an arrangement with the Eastern Extension Company, whereby the tariff with the Australasian companies was to be reduced .rom 9*s.* 4*d.* to 4*s.* a word. They had, however, the guarantee of the Governments of those colonies that the companies should not receive less money than they received in 1890. These reductions in tariff must necessarily lead to a very great extension of the system generally. The company's Red Sea cables hed been in operation for nearly 20 years, and the directors would not do their duty to the company or the public if they neglected to prepare at once for this increase of traffic. They had, therefore, decided to lay another cable from Suez to Aden, which must cost at least £250,000. With a view to maintaining the respectable dividends which the company now paid, the directors thought it better to pay for that cable at once, and he thought their policy was better conducive to the value of the shareholders' property than by adding to the capital now and eventually reducing the dividends. He moved the adoption of the report and accounts, and to declare a dividend on the preference shares to 30th June, 1890, at the rate of 6 per cent. per annum (less income tax), and a further dividend of 2*s.* 6*d.* per share, with a bonus of 3*s.* per share (free of income tax), on the company's ordinary shares, making, with the previous payments on account, a total of 6½ per cent. on those shares for the year ending March 31st, 1890.

The Marquis of Tweeddale seconded the motion.

Mr. Parsons, a shareholder, assailed the policy of the board, and said that had the company been directed by a body of practical

men, the dividends would have been very much larger. His opinions, however, were apparently not shared by the meeting.

The Chairman thought the meeting would share his contempt for the very remarkable jumble of ideas and ancient history they had just heard, coming, as it did, from one who should know better, he having been some fifteen years ago in the company's service. He, the chairman, had never listened to a greater display of vindictiveness with so little reason.

Mr. Parsons, on rising to make some further observations, was peremptorily informed that he could not be heard.

Mr. J. Gibb then moved a resolution, in which the shareholders expressed their sincere sympathy with Sir John Pender and his family in their present affliction, and which was carried unanimously.

Another Shareholder moved an expression of the obligation which the shareholders felt themselves to be under to Sir John Pender, Sir James Anderson, and other members of the board for their efforts in connection with the Telegraphic Conference, and, with a vote of thanks to the board for its conduct of the company's business generally, the meeting came to an end.

The Elmore Wire Manufacturing Company, Limited.

MR. GEORGE SMITH, chairman of the Kent Waterworks Company, presided, in the absence of Sir John Morris, at the first general meeting of the company, held at the Cannon Street Hotel on the 14th inst. He explained that it was a formal statutory meeting without report and accounts. But as the shareholders might desire to know what the directors had been doing in the four months of the company's existence, he went on to say—First, as to the subscribed capital: Notwithstanding the adverse state of the financial world at the time of the launching of the company, about 500 applicants had subscribed for shares, and an ample allotment had been made to carry on the company's business. Secondly, as to the company's relations with the Stock Exchange: Application had been made for a quotation and a settlement, and, upon the shareholders agreeing to the proposed alteration in the articles which the Stock Exchange required, the company would doubtless have its application granted. A special meeting would be held for that purpose. Thirdly, as to the land acquired: 12 acres of freehold land had been secured adjacent to the parent company's works at Haigh Park, Leeds, and manufacturing buildings had been erected there under the responsible supervision and control of the company's managers. Fourthly, as to plant: Orders had been given for plant, and would be followed up judiciously until the factories are completed and set to work, which, it was anticipated, would be before the close of the year. The directors' arrangements, with regard to the company's works, had been influenced by the consideration of the many advantages of having them contiguous to those of the parent company, whereby the company would be in a position to share with the parent company the services of the Messrs. Elmore, and so economise an important item of its working expenses, whilst it would secure the presence of Messrs. Elmore always at hand. Fifthly, as to the company's policy: The policy which the directors had elected to follow had been to work with, rather than against, the wire manufacturing trade, and they were happy to be able to say that a very substantial group of Birmingham wire-drawers had offered to take the whole of the company's output of spirals for 1891, with prospective arrangements for continuing the agreement at a price which would yield substantial results to the company. The advantages of such an arrangement were many and obvious. First, the company secured an established trade for all it could make without having to create a trade; secondly, the company enlisted the interested co-operation of some of the most important manufacturers of wire in the company, instead of having them for rivals; thirdly, it avoided bad debts, the firms in question being of the highest standing; and fourthly, the company was released from capital expenditure for wire drawing, and thereby enabled to lay down more deposit plant, and to simplify and increase its business. The terms had been approved, and the agreements would shortly be executed and exchanged by the parties. The directors therefore felt they might congratulate the shareholders of the company upon the prospects before them. Those of them who might wish to see specimens of the manufactures of this depositing process would find them exhibited at 56, Queen Victoria Street, and would do well to inspect them.

An extraordinary meeting was held immediately after the close of the above general meeting, when the following resolution was proposed by Mr. Smith, chairman, and seconded by Mr. Carson:—

"That the following clause be substituted for Clause 80 of this company's articles of association:—

"'The company may make contracts with any of the directors upon such terms as the directors shall think fit, and a director shall not by reason of the fiduciary relation subsisting between him and the company be accountable for any profits made by him in respect of any such contract, nor, subject to the following proviso, in respect of any other contract made with the company in the profits of which he participates, or in which he is otherwise interested, provided that the fact of his being so interested therein, and the nature of his interest, be fully and fairly disclosed by him at the meeting of the directors at which the contract is determined on, if his interest then exists, or in any other case at the first meeting of directors after the acquisition of his interest; but in the case of contracts with companies or firms of which any director of this company is a member, it shall not be necessary to disclose more than the fact of such membership, provided always that in no case shall such director so interested vote, or, if he does vote, his vote shall not be counted.'"

The Chairman explained that the resolution will be submitted for confirmation as a special resolution at a second extraordinary general meeting, of which due notice will be given.

The Company's Solicitor explained that the proposed alteration of the articles of association is necessary in order to comply with the requirements of the Stock Exchange Committee, before that body will give this company a special settlement and official quotation of its shares.

The resolution was agreed to unanimously, and the proceedings terminated.

National Telephone Company, Limited.

THE tenth ordinary general meeting of the shareholders was held at the City Terminus Hotel, Cannon Street, E.C., on Friday, the 11th inst., at 12 o'clock, to receive and adopt the report of the directors and the accounts for the year ending 30th April, 1890 (printed in our last issue).

The Chairman, Mr. F. B. Leyland, said that the whole of the amalgamation expenses, by which he meant the Government tax on the increased capital, and the tax on the transfer from the United, and Lancashire and Cheshire Companies, had been included in the year's accounts. The directors had acted on the principle that everything that could be possibly included in the expenses of the year should be so included and paid out of the year's earnings; and, in distinguishing between capital and revenue expenditure, the directors had, in the absence of any doubt, thought it desirable to err on the side of leaving the capital as little augmented as possible. Perhaps the most important consideration was contained in the recommendation made in concluding lines of paragraph I. of the report. That recommendation was made very much upon the same lines and policy as had been pursued in making up the accounts. The directors thought it desirable, now they had a year at least before them, to strengthen their position by adding to the reserves and declaring only a moderate dividend. Six per cent. was not an unsatisfactory dividend. They had to face the fact that competition might arise. They knew that one competing company had already been formed in Manchester. Fortunately it was not a very strong one, and it had a good deal to learn, as they would find. The patent which would be the first to expire was the Bell receiver, which would expire in December. He had been told that it would be utterly impossible for the competing company to carry on its business as it said at the expiration of that time. The patent might be used for a small exchange with advantage, but would be impossible in a large exchange. Their competitor would have to wait until the second patent, viz., the transmitter, expired in July, 1891. But even then there would be other patents which did not expire until 1893, and were all of material advantage to a good service. Letters had appeared from time to time in the Press, from the Mutual Company and others not connected with it, but apparently taking a very great interest in telephone matters; and, more especially, there was the speech of the Duke of Marlborough in the House of Lords; the statements contained in them all seemed to be founded on the assertion that the telephone service abroad could be done for very little—something like £4 6s. 8d. per subscriber—the charge made in Norway, in Sweden. How could they possibly compare Stockholm and Christiania with London, Manchester, Liverpool, Glasgow, &c.? Then, a large item in the construction account was for poles for carrying the wires. In Norway and Sweden they had these poles on the spot. There was also the relative cost of labour to be considered. Then companies in Norway and Sweden were not subjected to a tax of 10 per cent. on their gross income. Foreign companies were not required to pay for way leaves, whereas the amount which the company had to pay for way leaves was £25,000 per annum. The Duke of Marlborough said that in Paris there were three or four times as many subscribers to telephones as in London. The fact was, there were 7,800 subscribers in Paris, and 5,800 in London. That was a sample of the reckless statements that were made outside. The Duke also said that the charge for the telephone in London was £20 a-year, whereas the average charge in all continental capitals was only £6. Let them take Paris. The companies there used to charge £24. The Government took over the telephones, and, having no desire to make a profit, reduced the charge to £16. They must go a long way among European capitals to get anything like an average of £6, when they commenced at £16. In the French provinces subscribers had to buy their own apparatus and pay the cost of the wire as well. In Berlin, and throughout Germany, an average charge was made all round of £7 10s.; but then there was no 10 per cent. payable to the Government, no cost of way leaves. The Government might fix the standard on your house-top or in front of your door—whether you liked it or not. In Madrid the charge was £12; St. Petersburg, £23 2s. 6d.; Sweden and Norway, £4 8s. 10d. and £4 8s. 1d.; but in these countries they only allowed you a certain number of conversations in the year, and charged you an extra amount for every conversation above that number. In New York they charged £30 to £36; Boston, £19 to £24; Chicago, £25; Pittsburg, £16 16s. to £20; Washington, £12, £16 and £20, according to distance; New Orleans, £19 15s.; Philadelphia, £24. As regards dealing with competition there would be no relinquishment of the company's position, and all measures necessary to strengthen it, and to keep the field, for it would be

taken. Economy of working and efficiency of service were most important considerations. Efficiency of service had been the first to engage the directors' attention. They had found, in London especially, that a great many of the switchboards were of an antiquated pattern. These had all been replaced with the exception of two. Then they had had to deal with the junction wires. One of the greatest defects of the London system had been the multiplicity of these exchanges. These had been considerably reduced, in the City especially, and the reduction would be continued until, if possible, the whole was got into one or two exchanges. The junction wires had been improved and looped to the extent of 350 miles, and there were 1,200 still to be done. Some 1,700 of the instruments had been fitted with magnetos, leaving about 350 to be done, and various other improvements had been made. To have done more than had been done would have involved a serious stoppage of the service. As regards the trunk line to the North he was very pleased to be able to tell them that they had at last got into communication with Manchester, Liverpool and Birmingham. The trunk lines would be one of their great standbys in competition. They were now pretty well all over the country. They had all been profitable, i.e., they returned a fair interest for money expended. They had now a larger business being carried on at practically the price for which they had formerly carried on a much less important one, and he had no doubt that next year they would have a better report—certainly one as good. They must, however, take the labour difficulty into account. Everyone was asking for an increase in wages. The taking over of the Northern District Telephone, completed about a month ago, was, he thought, a wise thing for themselves, and he was sure a necessary thing for the Northern Company. It saved considerably in the working expenses, and secured a promptness of decision on the part of the board which could not be when they had three separate boards. The policy of the amalgamated companies was to include the South of England and the Western Counties, the only two counties now outside the amalgamation. That was, however, a question of price. The number of proxies sent in, viz., 81,788 shares out of 468,984, was a substantial expression of opinion in favour of the board. He had recently received a letter from a very important shareholder, and one who had considerable experience in financial matters, on the question of dealing with the reserve fund. The writer appeared to be in favour of investing it in marketable securities. If so, they ought also to invest in securities in which there was not a large fluctuation in price. But in that case, there was little chance of more than a very low interest. Where was the policy of investing money which would not give more than 3 per cent. and borrowing money for the purpose of extending capital, paying 4 per cent. for it at the least. At present the reserve was being largely employed in buying up the Northern District. The old shareholders were given the choice of payment in the company's ordinary shares, or in sovereigns. They chose the latter, whereby the company made a better bargain. The policy of the board would be a big reserve and a moderate dividend. He moved that a dividend at the rate of 6 per cent. per annum (less income tax) on the first and second preference shares, and on the fully paid ordinary shares (excluding the 52,109 new ordinary) be paid for the half-year ending 30th April last, making, with the interim dividend already paid, a total dividend of 6 per cent. for the year.

Mr. J. S. Forbes seconded the motion, which was carried unanimously. Messrs. Welton, Jones & Co. were reappointed auditors, and with a vote of thanks to the board, the meeting came to an end.

United River Plate Telephone Company, Limited.

The report of the directors to be presented to the shareholders at the fourth ordinary general meeting to be held at Winchester House, 50, Old Broad Street, E.C., on Tuesday, the 22nd July, 1890, at 12 o'clock noon, states the result of the company's operations during the year ending 31st March last, after paying all working expenses abroad, debenture interest, London and other charges, is a profit of £34,198 6s. 5d., from which has to be deducted the sum of £22,334 17s. 1d. for loss on exchange, leaving a net profit of £11,863 9s. 4d., increased by the balance of £1,210 7s. 2d. brought forward from the previous year, to £13,073 16s. 6d. Out of this, an interim dividend of 2 per cent., or £5,800, was paid in January last; and the directors recommend that out of the remaining balance of £7,273 16s. 6d., a further dividend of 1 per cent., or 1s. per share, free of income tax, be now paid, which absorbs £2,900; that £2,000 be placed to the depreciation and renewal fund, thereby increasing it to £9,000; and that the balance of £2,373 16s. 6d. be carried forward to the credit of profit and loss account for the current year. As shown in the balance sheet annexed, the capital expenditure during the year amounted to £12,772 8s., as against £35,070 2s. 11d. in the previous twelve months. The business of the company has largely increased during the past year, the gross receipts having been £108,612 2s. 7d., as compared with £81,866 2s. 4d. in the year before; such a development of business has necessarily increased the working expenses in the River Plate, and the continued depreciation in the currency there has naturally given rise to a necessity for higher wages. In spite of these difficulties, the result of the company's working would have been very satisfactory but for the serious increase (more especially during the second half-year) in the loss on exchange, which amounted to £22,334 17s. 1d., as against £14,689 6s. 8d. in the previous year, the net profits having been thereby so reduced as to make it impossible for the directors to recommend so high a dividend as last year. But to meet this loss on exchange to some extent, the directors raised the rates of subscription on the 1st January last, and they are glad to say that the change has been carried out successfully. The shareholders will remember that the directors were authorised at an extraordinary general meeting held on the 9th January this year to issue debenture stock and convert the then existing 7 per cent. debentures; and the directors are glad to report that out of £100,000 7 per cent. debentures, £97,000 have been converted into 5 per cent. debenture stock, and that £29,000 of the same stock, offered to the shareholders, was largely over-subscribed. Under the articles of association, the Right Hon. Lord Thurlow and Mr. Frederick Green retire by rotation at this meeting, but, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. & Co., also retire, but offer themselves for re-election.

Crompton and Company, Limited.

THE second report of the directors, to be presented at the annua general meeting of the shareholders at the City Terminus Hotel, Cannon Street, in the City of London, on Monday, the 21st July, 1890, at 2.30 o'clock, p.m., states:—The net profits for the year amount to £10,610 1s. 7d., and after payment of the interim dividend last December, and providing for debenture interest and other payments set out in the accounts, there remains a balance of £6,030 6s., from which the directors propose, after setting aside a sum of £500 as a provision for doubtful debts and contingencies, to declare the usual dividend of 7 per cent. per annum upon the preference shares, and 5 per cent. per annum upon the ordinary shares, carrying the balance forward. The business of the company has greatly increased, necessitating considerable extension of the works, and large additions to plant. The contract for the public lighting of Chelmsford has been carried out, and the result has given great satisfaction in the town. It is hoped that private consumers will now apply for the light in sufficient numbers to make the contract a profitable one. The installation has cost more than the original estimate, largely in consequence of unexpected and difficult requirements of the Board of Trade. Very important contracts have been arranged with several of the electric supply companies in London, the principal feature of which is that this company receives a fixed profit upon the actual cost of the works, and large orders are also in hand for other companies and firms, the prospects of the present year being in consequence very good. It is with the greatest regret that the directors have to record the loss, by death, in October last, of Viscount Torrington, the chairman of the company. In accordance with the articles of association, Sir Charles Grant retires from the Board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan & Co., also offer themselves for re-election.

The Direct United States Cable Company, Limited.—The board has resolved to recommend a final dividend of 3s. 6d. per share, free of income tax, such dividend to be payable on and after the 26th instant, making, with the interim dividends already paid, 3½ per cent. for the year ending 30th June last, carrying forward £968 0s. 3d., after having transferred to the reserve fund account £8,502 14s. 5d., making it up to £250,000. Notice is also given that the transfer books of this company will be closed from the 11th to the 25th July, both days inclusive.

The Edison and Swan United Electric Light Company, Limited.—The directors announce a dividend at the rate of 7 per cent. per annum on the "A" shares for the half-year ended the 30th ult. (making 7 per cent. for the year), and a further dividend of 4 per cent. in completion of payment of arrears of cumulative preference dividend for the year ended June, 1884, and a further dividend of 4 per cent. in respect of arrears of cumulative preference dividend for the year ended June, 1885.

Parker's Electric Wire Corporation, Limited.—A general meeting of the members of this company will be held in Temple Chambers, Temple Avenue, London, E.C., on the 12th August, at 4 p.m., when an account will be produced of the winding up of the company, and other business transacted.

MacMahon's Electric Automatic Registering Company, Limited.—A general meeting of the shareholders will be held at the office of the liquidator, Mr. Wm. G. Jefferys, 53, Coleman Street, London, E.C., on the 18th August next, when the liquidator's accounts will be produced.

The Globe Telegraph and Trust Company, Limited.—The directors propose a final dividend of 4s. 3d. per share, making 5 per cent. for the year ending the 18th inst., a balance of £108 being carried forward.

The Edison Electric Illuminating Company, New York, has declared a quarterly dividend of 1 per cent., payable August 1st.

TRAFFIC RECEIPTS

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 14th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,644.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 10).	Closing Quotation. (July 17.)	Business done during week ending July 17, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 —100 xd	97 —100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51		
2,725,420	Do. do. 6 p. c. Preferred	Stock	85½— 86¼	86 — 87	86⅞	86
2,725,420	Do. do. Deferred	Stock	14 — 14½	14½— 14⅝	14¼	13⅞
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12⅛xd	11½— 12⅛	11⅛	11⅛
99,000	Do. do. 5 p. c. Bonds...	100	103 —104	102 —104		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 —107xd	103 —107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ..	3	1⅞— 2⅛	1⅞— 2	2⅛	2⅛
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅝— 1⅞	1⅝— 1⅞		
$7,216,000	Commercial Cable, Capital Stock	$100	103 —105	103 —105	103⅞	103¾
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	⅛ — ¼	⅛ — ¼	¼	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5½	5¼— 5½		
16,900	Cuba Telegraph, Limited	10	12½— 12⅝	12⅝— 13¼	12⅝	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	17⅞	...
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜		
6,090	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10¼— 10⅜	10¼— 10¼	10 5/16	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13¾— 14¼	14 — 14⅛	14 3/16	14
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15¼	...
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 —111	108 —111		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	107	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14¼— 14½	13⅞— 14¼xd	14⅛	13⅞
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	101 —103	101 —103		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106 xd	103 —106	103¼	...
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106 xd	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 —103 xd	100 —103	101⅛	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5¼— 6	5⅞— 6¼	5 13/16	5¼
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2 — 2½	2 — 2⅛		
180,227	Globe Telegraph and Trust, Limited	10	9 — 9½	9⅛— 9⅝	9 5/16	9
180,042	Do. do. 6 p. c. Preference	10	15¼— 15⅝	15¼— 15⅝	15 5/16	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	15⅝— 16¼xd	15⅝— 16¼xd		
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	100 —103 xd	100 —103	101	...
250,000	Do. do. do. (issue of 1883) ...	100	105 —108	105 —108		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½— 12⅛	11½— 12⅛		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	19 — 20	18½— 19½xd	19¼	19¼
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	4⅛— 5	4⅛— 4⅛	4⅛	...
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5⅛— 5⅜	5⅛— 5⅜	5⅛	5 1/16
49,825	Do. New Nos. 386,876 to 436,700	5	5¼— 5⅛	5⅛— 5⅜	5⅜	...
15,000	Do. 6 p. c. Cum. 1st Preference	10	12½— 13	12½— 12⅝		
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10½— 10⅝	10½— 10⅝		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	⅛— ¼	⅛— ¼		
9,000	Reuter's, Limited	8	7⅞— 8¼	7⅞— 8¼	7 13/16	...
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ...	⅛— ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3¼ only paid)	5	2¾— 3¼	2¾— 3¼		
3,381	Submarine Cables Trust	Cert.	112 —116	112 —116	114	...
78,949	Swan United Electric Light, Limited ... (£3¼ only paid)	5	5 — 5⅛	5 — 5⅛	5⅛	5⅛
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	43 — 45 xd	44½	44
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102 xd	100 —102		
55,000	United River Plate Telephone, Limited	5	4⅛— 5	4⅛— 4⅜		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94 xd	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ... xd	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9½— 10⅛	9 — 10 xd		
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	99½	...
30,000	West Coast of America Telegraph, Limited	10	6½— 7	6 — 6½		
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ..	100	108 —112 xd	106 —110	108½	107⅞
64,572	Western and Brazilian Telegraph, Limited	15	9⅜— 10⅛	10 — 10⅛	10⅛	10 1/16
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6 13/16	...
26,986	Do. do. do. 5 p. c. Deferred	7½	3½— 4	3⅝— 4¼	4	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅜— 2⅝	2⅜— 2⅝	2½	2 7/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11 — 11½	11 — 11½	11½	11⅜
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	12½— 13½	12½— 13½		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 2	1½— 1⅝		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Electric Construction Corporation (£10 paid), 8¾—9.—House-to-House Company (£5 paid), 4⅞—5⅛.—London Electric Supply Corporation, Ordinary (£5 paid), 1¾—2⅛.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-. Elmore Wire, ¼ dis—par.

BANK RATE OF DISCOUNT.—4 per cent. (26th June, 1890).

ELECTRIC LIGHTING AND COUNTY COUNCIL.

PROVISIONAL ORDERS FOR NEXT SESSION.

AT the meeting of the London County Council on Tuesday last at Spring Gardens, under the presidency of Sir John Lubbock, Mr. T. B. Westacott (the chairman of the Highways Committee) presented a report, which stated, for the information of the Council, that the following notices of intended applications next session for provisional orders under the Electric Lighting Acts had been received :—

Undertakers.	Areas of Supply.
St. James and Pall Mall Electric Lighting Company.	Parishes of St. James, Westminster; and St. George, Hanover Square.
Brush Electrical Engineering Company.	Parishes of Fulham, Hammersmith, Islington, Shoreditch, St. Luke, Clerkenwell, Bethnal Green, and Districts of Hackney and St. Saviour.
Laing, Wharton and Down Syndicate.	City of London (east and west districts); Parishes of Shoreditch and Islington; and Districts of Hackney and Whitechapel.
Westminster Electric Supply Corporation.	Parishes of Paddington, Chelsea, St. Marylebone, Kensington, and St. Margaret and St. John, Westminster (part of).
New Cadogan and Belgrave Electric Supply Company.	Parish of St. George, Hanover Square.
Ditto ditto ...	Parish of Chelsea.
London Electric Supply Corporation.	Area not specified.
Metropolitan Electric Supply Company.	Ditto

LONDON ELECTRIC SUPPLY CORPORATION.

The same committee reported that they had considered a notice from the London Electric Supply Corporation (with one plan) of intention to lay trunk mains in Stamford Street, York Road, Sutton Street, and Belvedere Road; together with a letter from the company asking that, as it had arranged a new route for its mains, this notice might be taken in substitution for that dated April 18th, 1890, the works referred to in which were approved by the council on May 1st last. "The council will probably not think it desirable to interfere with the discretion of the company with reference to the route to be adopted for its trunk mains; but your committee think that, in order to obviate the necessity of a second interference with the same streets, the company should be required to lay its distributing mains at the same time as the trunk mains. Your committee therefore recommend :—'That the sanction of the council be given to the works referred to in the notice (Registered No. 96) of the London Electric Supply Corporation, dated June 19th, 1890, upon the following conditions :—That the distributing mains be laid at the same time as the trunk mains, in order to avoid a second interference with the same streets; that the mains be protected from injury by a sufficient outer covering, to the satisfaction of the council's engineer; and that the company do give three days' notice to him before commencing the work in any of the thoroughfares referred to in the notice.'"

The same company had also asked for the consent of the council to an alteration of the route of its mains in Cockspur Street, from the south side, as shown upon the plan submitted with the notice dated June 4th, 1890, sanctioned by the council on June 24th last, to the north side of that street. "This alteration, which is shown upon a plan submitted by the company, requires to be made in order to meet the wishes of the Postmaster-General; and your committee, seeing no objection to it, recommend :—'That the Council do consent to the alteration of the route of the London Electric Supply Corporation's mains in Cockspur Street (referred to in the notice Registered No. 90), as shown upon the plan submitted by the company.'"

Both these recommendations of the committee were approved by the council.

MISCELLANEOUS.

The Highways Committee further reported that they had considered a letter from the Board of Trade, forwarding, for the observations of the council, a copy of an application from Messrs. Woodhouse and Rawson United, Limited, for permission to purchase from the West Middlesex Electric Lighting Company the undertaking authorised by the Fulham District Electric Lighting Order, 1884, which order was revoked by the board in October last. This order did not, of course, contain the provisions conferring powers upon the council, introduced last year for the first time into electric lighting orders relative to the County of London, and the committee did not consider that it would be desirable to revive an order of the old form, unless it could be brought into conformity with those of last year. They therefore recommended, and the council resolved, as follows :—"That the Board of Trade be informed that in the opinion of the council the permission asked for by Messrs. Woodhouse and Rawson United, Limited, should not be granted, unless the provisions of the Fulham District Electric Lighting Order, 1884, be so modified as to make them accord with the orders recently granted by the board."

Mr. JOHN HUTTON, as chairman of the Building Act Committee, submitted their report, which made the following, among other recommendations, which was agreed to :—"That the application of Mr. E. Garcke, on behalf of the Brush Electrical Engineering Company, Limited, for approval of a plan for the construction of an addition to a temporary iron building in Belvedere Road be not granted, as the committee consider it undesirable to sanction the erection of any additional temporary structure at the premises in question."

BARNSLEY AND ELECTRIC LIGHTING.

MR. J. H. TAYLOR, borough surveyor, has prepared a report on the proposed electric lighting of Barnsley. The report gives the results of the labours of the Park and Lighting Committee of the Barnsley Town Council in the matter, they having had it under consideration for almost a year past. It states that tenders were invited, but the "high charges and excessive terms of purchase asked by the companies" were such that they were compelled to relinquish all ideas of introducing the electric light to Barnsley by the medium of a private company. The committee then invited tenders for the supply and erection of a complete plant for lighting with electricity the streets, roads, and other places within what is called the inner area, and which practically comprises the whole of the business portion of the town, and also for lighting 5,000 10-candle-power lamps, or their equivalent in arc and incandescent lamps, in buildings within the inner area. The corporation in this case is to provide the buildings, the contractor to provide and build the foundations for all engines, dynamos, and boilers, and to lay out the plant in the best manner of extending the same, so that eventually the whole of the borough may be lighted from the central electric lighting station, appliances to be provided for supplying 50 arc lamps of 1,200 candle-power each; 142 incandescent lamps of 32 candle-power each; and 5,000 lamps of 10 candle-power each, or their equivalent in arc and incandescent lamps, and with one engine and boiler, and one each of the arc and incandescent light dynamos to spare. Lamps and posts for 50 arc lamps and 140 incandescent lamps are to be provided of ornamental design in iron; the cables and wires of copper properly insulated and erected overhead. The necessary precautions for the proper carrying out of these tenders are taken. In response to these proposals tenders were obtained from several companies. The Gülcher (New) Electric Light and Power Company, Limited, offer to do the work for £25,500, subject to a reduction of £2,000 if bare copper mains are used. The Electric Construction Corporation, Limited, submits two tenders—one of £22,751, and the other of £21,721. The Manchester Edison-Swan Company, Limited, tender to do the work for £19,200, or for £2,000 less if the cable supports are made partially or entirely of wood. The other tenders are :—Westinghouse Electric Company, Limited, £17,800; Laing, Wharton and Down Construction Syndicate, Limited, £16,975; Brush Electrical Engineering Company, Limited, £13,100; and National Electric Supply Company, Limited, £11,888. On these tenders and the whole scheme proposed for the electric lighting of the borough, Mr. A. Bromley Holmes, electrical engineer, of Liverpool, was consulted, and he recommended the adoption of the "high tension alternating system" as the best and most suitable for a town like Barnsley, and after giving his reasons against the proposals of the other companies, so far as Barnsley is concerned, recommends that of the Westinghouse Electric Company, Limited, £17,800, as the most favourable. In a subsequent report, Mr. Holmes states that he has inspected the Westinghouse installation at Sardinia Street, London, made by the company for the Metropolitan Electric Supply Company, Limited, and finds the arrangement simple and practical, the plant well designed and constructed, and working in a perfectly satisfactory manner. Certain modifications suggested in the original tender have been agreed to by the company, and Mr. Holmes says he can now recommend its acceptance, and adds that in the estimate of capital expenditure it would be well to add £700 for mechanical stokers on the boilers, and for additional transformers, making a total of £18,500. He submits an approximate estimate of such a station for Barnsley, as follows :—Cost of water, oil, waste, &c., £1,450; renewal of carbons and street incandescents, £225; salary of chief engineer and assistant, £350; wages of enginemen, stokers, linemen, and labourers, £936; collector and clerk's assistance, £200; sundry expenses, £200—£3,361. Interest, sinking fund (five per cent. on cost of site and buildings, £4,000), £200; 10 per cent on cost of plant, &c., including repairs (£18,500), £1,850—£2,050; making a total estimated annual cost of £5,411. Mr. Holmes adds :—"Assuming the 5,000 ten candle-power incandescent lamps to be used on the average 800 hours per annum, each lamp would consume approximately 32 units of electricity, which, if sold at 6d. per unit, would bring in a revenue of £4,000. Deducting this sum received for private lighting from the working costs given above, would leave a balance of £1,411 as against the street lighting. The street arc and incandescent lamps would replace 248 gas lamps, giving a total light of 6,574 candles, costing £800 per annum. The 50 arc and 140 street incandescent lamps would give a total light of 54,480 candles. The cost of extending beyond the inner area would probably be £50 for each arc lamp and £10 for each 32 candle-power incandescent lamp." On these facts and figures the committee recommend that the tender be accepted of the Westinghouse Electric Company.

REVIEWS.

Derivation of Practical Units. By Lieut. F. B. BADT and Prof. H. S. CARHART. Electrician Publishing Company: Chicago, U.S.A.

This small work is mainly a reprint of articles published in the *Western Electrician*. Its title, though it no doubt is, strictly speaking, correct, is, we think, very liable to be misleading, as the book is not a scientific treatise on electrical units, but a series of short illustrated biographies of famous electricians to whom the system of electrical units is practically due and by whose names the units are designated. A final chapter by Prof. Carhart deals briefly with modifications of the practical units.

Inventions and How to Patent Them. A Practical Guide to Patentees. By EUSTACE SMITH. Third Edition. Revised. London: Whittaker & Co., Paternoster Square.

This is an exceedingly handy and useful little volume, and should be possessed by all who are interested in the subject. The sections into which the work is divided are as follows:—What is a Patent? What Inventions can be Protected by a Patent? When is a Patent New? When is a Patent Useful? What amount of Invention is Necessary to Support a Patent? Who may apply for a Patent? How to obtain a Patent; Dealings with Patents; Retention of Patents; Information on Practical Points.

Journal of the Institution of Electrical Engineers. No. 87. London: E. & F. N. Spon, 125, Strand.

The contents of this number are as follows: "On Signalling across Rivers in India," by W. F. Melhuish; "The Diathermancy of Air in Relation to the Efficiency of Incandescent Lamps," by F. Higgins; "On Lightning Guards for Telegraphic Purposes, and on the Protection of Cables from Lightning," by Oliver J. Lodge; Original communications, Abstracts, &c.

ALTERNATING CURRENT MOTOR.

THE accompanying cut from an American exchange, illustrates diagrammatically an alternating current motor, recently patented by Elihu Thomson, of Lynn, Mass. Rotation in this motor is due to the reaction between an alternating current field and a locally short-circuited armature. These motors, when running at normal speed, are capable of sustaining speed in synchronism, or nearly in synchronism, with the alternations of the feeding wire, but are incapable of starting.

The invention consists in commencing to run the motor with a different circuit arrangement for its armature from that which it will have under the condition of steady normal working. This primary condition is one adapted to give a torque. When up to speed the motor is run with the armature on continually-closed circuit.

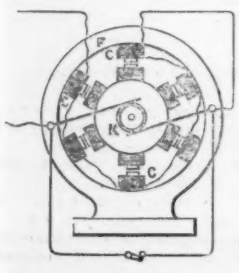

FIG. 1.

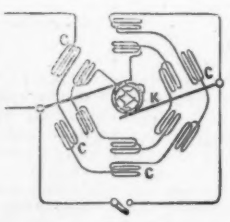

FIG. 2.

In the accompanying cuts, fig. 1 is a side elevation of a form of motor to which the invention may be applied. Fig. 2 is a diagram of the circuits and connections of the apparatus. In the figures, F represents a laminated field magnet frame having projections upon which are wound coils, C, as many as six in number. These projections extend inwardly toward a revolving laminated armature. Upon the shaft of the machine is a commutator, K, consisting of six segments, each alternate segment being connected, so that there are in reality but two divisions of three segments, each fitted together. The armature coils are so connected that if a continuous current were passed through the coils the projections on the armature would assume alternately north and south polarities. The field coils are connected in a like manner. Now if an alternating current be passed through the field coils, C, the motor will not start to rotate whether its armature circuit be practically open, or whether the coils be on closed circuit; but it will continue to rotate in either direction if it is once started, if the armature coils are placed on closed circuit, and the current fed to the coils, C, has sufficient energy. In the motor shown, the alternating current which passes through the field is made at the start to circulate through the armature. In the initial condition of the motor the brushes are set backward or forward into proper position, where the armature will begin to rotate. When a certain speed has been obtained, the motor is made to assume its normal working condition and to continue its rotation without the commutator by short-circuiting the armature by any desired means. These changes of condition may be made by devices manually operated; but the inventor prefers to bring them about automatically by the operation of some device responsive to the change of speed of the armature.

ACTION OF LIGHTNING UPON THE HUMAN ORGANISM.

ACCORDING to Vienna papers of the 4th inst. Prof. Nothnagel, in his clinical lectures, yesterday exhibited to his hearers a young woman, aged 20, Josepha Schleser, who had been recently struck by lightning in Styria, and had come to Vienna for treatment in Prof. Nothnagel's hospital. The patient suffered from a derangement of the nervous system. To his remarks on this case the lecturer added a discourse on the effects of lightning, substantially as follows: Formerly it was known merely that the burns occasioned by lightning had a zigzag figure, and that the further consequences might be paralysis or death. During the last ten years the lecturer had made comprehensive experiments upon rabbits with the electric spark of a large Leyden jar, and has thrown a new light upon this question. The action of lightning upon the brain, the spinal column and the peripheric nerves is shown by the loss of consciousness, the disturbance of the intellect, and the extended phenomena of lameness, the latter of which have a tendency to disappear. On the other hand, there are intense nervous phenomena which strongly resemble those produced by railway accidents and other concussions, and which dominate the patient for a long time. Disturbances of sight and speech often occur, and may remain for life, or may in part disappear. In other cases there may be observed in the person struck a childish frame of mind which may incline either to reckless merriment or to sadness and melancholy. Experience proves that lightning produces its chief effects only at the points of its entrance and exit. Thus a flash which entered a schoolroom injured only the first and last child on the form, those between escaping unhurt. Prof. Nothnagel pointed out that in the treatment of lameness and other constitutional perturbations due to lightning metallotherapy is most efficient, a large horseshoe magnet being applied alternately to the head, trunk and the limbs. This process led to better results than the electric treatment recently adopted. In case of a quite recent stroke the clothing should be unfastened, the patient laid with the head high, quietness and fresh air should be secured, and if consciousness does not return the head should be exposed to a stream of cold water.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"The Working Efficiency of Secondary Cells." By W. E. AYRTON; C. G. LAMB, E. W. SMITH and M. W. WOODS, Associates. Read at Edinburgh, Wednesday, July 16th.

I.—PREVIOUS TESTS OF CELLS.

Since 1881, when the formation of Planté storage cells was greatly accelerated by Faure's device of pasting the plates, numerous tests have been made in different parts of the world on the capacity and efficiency of secondary cells. The first tests that were carried out were conducted simultaneously, at the end of 1881, in England by Prof. Perry, with one of the authors of this paper, and in France by a committee consisting of Messieurs Tresca, Potier, Joubert and Allard, working at the Conservatoire des Arts at Metiers, with a staff of assistants.

In the report—communicated to the Physical Society in February, 1882—by the two English experimenters, it was pointed out that the great "resuscitating power" of the cells made it very difficult to say when they were entirely discharged, and therefore, in order to test the efficiency, the cells were first "emptied" of charge by discharging them until the discharge current was very small, and finally leaving them short-circuited for many hours with a short bit of thick wire. Next, a measured amount of energy was put into these "empty" cells, and they were then thoroughly discharged on three successive days, being insulated and allowed to recuperate during the two intervening nights. Although the energy efficiency thus obtained, and which was not less than 82 per cent., probably represented much more than could be obtained in practice at that period, if the discharge were stopped before the E.M.F. fell to so low a value, this efficiency represented something quite definite, since all the energy given out by the cells in the discharge must have been put into them during the measured charge, no demand being made on some inexhausted store of energy previously put into the cells.

The French committee, on the other hand, considered the cells as being discharged when a certain current which was originally produced through a fixed resistance by 30 cells could no longer be kept up, even when the number of cells had been increased to 35. But unless, subsequently to the receipt of the cells from the manufacturers, they had been charged and discharged several times until the same cycles of values of E.M.F. with time were repeated with each charge and discharge, there was no guarantee that in the experimental discharge the cells were not drawing on a store of energy put into them before leaving the manufacturers' premises, and thus giving a higher value than the "working efficiency."

And we are afraid that a very possible neglect of the powerful resuscitating power of accumulators may have vitiated some of the published results of experiments that have been made on them. This doubt must not be forgotten in considering the accompanying list, which is as complete as we have been able to make it, of all such experiments that have been made up to date. At the middle of 1889, when we had nearly completed our investigation, there appeared two very important contributions to the subject—one on "The Inherent Defects of Secondary Batteries," by Dr. Louis Duncan and H. Wiegand; the other, "Ergebnisse von Versuchen an Akkumulatoren für Stationsbetrieb," by Prof. W. Kohlrausch and C. Heim. These investigations are extremely interesting, as they confirm some of the results which we had also arrived at, and to which reference will be made in this paper; Prof. W. Kohlrausch and C. Heim, for example, laying great stress on the fact that the discharge of an accumulator does not depend merely on the previous charge, but on the previous history of the cell.

At the Central Institution there are three distinct types of E.P.S. cells in daily use. The cells, however, used by us for the investigation were 20 out of a group of 50 of what is known as the 1888 type. This type we selected since it was the latest constructed by the Electrical Power Storage Company. The particular specimens of this 1888 type, which are at the Central Institution, contain each two positive and three negative plates, each plate, exclusive of the lugs, being 9¼ by 9¼ inches. The glass vessels containing these plates are large enough to each hold 7L plates, but we preferred to use 7L glass boxes to having smaller boxes specially constructed.

The total weight of each of these cells is about 59 lbs. 12 oz., made up as follows:—

		lbs.	oz.
3 negative plates	about	17	2
2 positive „	„	11	8
Ebonite strips	„	0	8
1 glass vessel	„	7	8
Dilute sulphuric acid...	„	23	2

and the cells are intended to be used with a maximum current of 9 ampères on charging and 10 on discharging.

The first point to settle with reference to the discharge was whether the resistance in the circuit should be kept constant, or whether as the E.M.F. fell the resistance should be varied in such a way as to keep the current constant. This latter method, although it involved much more labour, was adopted. At first the current was kept constant by varying the resistance by hand as the E.M.F. of the cells altered. But this required the constant presence of one of the observers day and night, partly to vary the resistance from time to time, and partly to start the charging directly the discharging was finished, in order that the cells might never be left discharged. Hence an automatic arrangement, which will be described later on, was subsequently devised, and by means of it the current was maintained more constant than could be achieved by even very careful hand

Efficiency Tests of Accumulators.

Date.	Maker of Cell.	Experimenters.	Efficiency. Quantity.	Efficiency. Energy.	Remarks.
1882	Faure	Ayrton and Perry ...	...	82	Cells short-circuited for some time before being tested. Cells discharged on three successive days, and allowed to recuperate during the two intervening nights.
1882	„	French Commission ..	92	70	Result of a week's work. Current kept fairly constant during discharge by the addition from time to time of fresh cells.
1883	Schultz	Hallwachs	...	6 to 50	Results variable and indefinite.
1883	E. P. S.	H. Morton	90	...	
1883	... ...	Aron	...	6 to 50	Results very variable.
1885	B. T. K....	Forbes	80	69	Mean of one week's work. Current not kept constant.
1886	Farbaky and Schenek	Waltenhofen	91·7	78·7	
1886	E. P. S.	Drake and Gorham ...	90	80	Current maintained constant during charge and during discharge.
1887	... ...	Haebelin	92	...	"Cells not good."
1887	Fitzgerald	Lea	91	...	
1887	... ...	Huber	...	88	
1887	C. Smith...	Miller	80	...	Lead spirals painted over with salts.
1888	Huber	W. Kohlrausch	90·7	78·4	
1889	Farbaky and Schenek...	Waltenhofen	88·1	77·4	
1889	Tudor	W. Kohlrausch & Heim	94	82·4	Normal currents used in charging and in discharging.
1889	„	„ „	77	64·7	Charging and discharging currents rather more than twice the normal.
1889	„	„ „	81·4	71·7	Cells allowed to rest for 160 hours after charging.
1889	„	„ „	90	80	Cells first completely discharged by the external resistance being gradually diminished to nought. The positive plates of these Tudor cells are first formed by Planté's process, then the holes in the grids are filled with minium, and the forming continued. The negative grids are not formed at all, but merely have the holes in the grids filled with lead oxide.

regulation, and the circuit broken during discharging and during charging the moment the P.D. reached certain pre-arranged values.

We had next to adopt a criterion by which to settle when a charge or discharge could be said to be completed. Such a criterion may be made to depend on a variety of changes that take place in a cell, three of which are in common use—viz., change in the specific gravity, gassing, and change in the P.D. In the case of the cells tested by us, and which have more liquid in proportion to the plates than is usually the case, the change in specific gravity from charge to discharge is from 1·2 to about 1·17; and, as our experiments show that the change is directly proportional to the time, when the current is kept constant, the change in the specific gravity per hour is only about 0·002, which

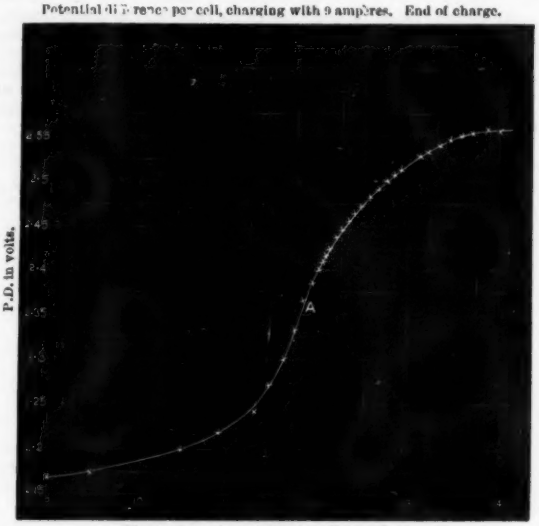

FIG. 1.

is far too small to be read very accurately with ordinary hydrometers. But it is known the fall in the E.M.F. of the cells at the end of the discharge is very rapid, so that half an hour more or less in the time of discharge produces a great difference in the value of the

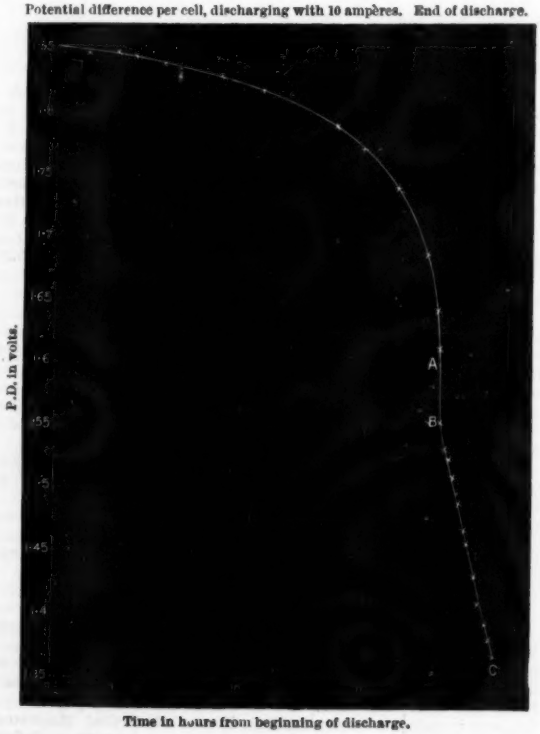
Potential difference per cell, discharging with 10 ampères. End of discharge.
P.D. in volts.
A
B
C
Time in hours from beginning of discharge.

FIG. 2.

E.M.F.; hence it follows that, if a specific gravity test were alone employed with our cells as a criterion of charge and discharge, it would be necessary to read the specific gravity accurately to less than 0·001 at the end of the discharge. The amount of gassing is also far too rough a test, and cannot be employed at all in the discharge, hence we were led to resort to the variation in the P.D.

A number of experiments were now made on two of the cells, in order that the *exact* shape of the curves of P.D. at the *end* of the charge and discharge might be ascertained. The curve shown in fig. 1 is the end of the P.D. curve for one cell on charging with 9 ampères for 14 hours; from which we see that the rate of variation of the P.D. with time is greatest when the P.D. is about 2·36 volts, indicated by the point, A. In fig. 2 is shown the curve of P.D. during the last 3½ hours of discharge with 10 ampères, the discharge being continued for 12 hours. In this particular experiment the discharge was allowed to continue until the P.D. fell to 1·365 volts, indicated by the point, C, which is far lower than we have dared on any other occasion to allow the P.D. to fall. At about 1·8 volts the P.D. curve begins to fall pretty rapidly, and the slope of the curve, or the rate of diminution of the P.D. with time, goes on increasing until the P.D. has fallen to 1·6. volts, indicated by the point, A, on the curve in fig. 2. Here $\frac{dv}{dt}$ per cell has reched a value 1·4, v being measured in volts and t in hours. Below this the curve has a shape that has not hitherto been noticed, for when the P.D. per cell has reached 1·556 volts, indicated by the point, B, the curve suddenly alters its shape, becoming the straight line, B, C, with a less inclination to the axis of time, $\frac{dv}{dt}$ being for this line only 0·44.

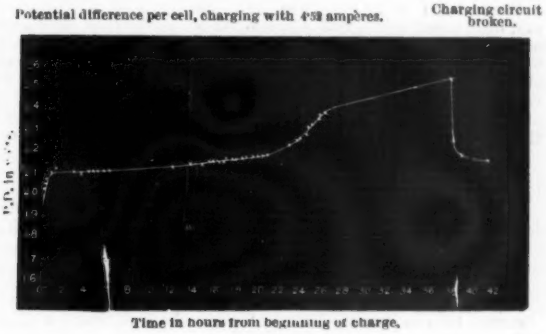
Potential difference per cell, charging with 4·52 ampères.
Charging circuit broken.
P.D. in volts.
Time in hours from beginning of charge.

FIG. 3.]

Just as we have in the curve in fig. 2 continued the discharge much below the usual limit, so we examined what would take place if the charging was also prolonged much beyond the usual limit. Curve 3 shows the rise of the P.D. when the charging at 4·52 ampères was continued for 37½ hours, 25½ hours being sufficient to fully charge the cells with this constant current of 4·52 ampères—that is, to charge them until the P.D. per cell was 2·4 volts. It will be observed that whereas the volts rise from 2·25 to 2·38 between 23·1 and 25·5 hours—that is, 0·13 volt per cell in 2·4 hours—the rise in the following 12·3 hours is only from 2·38 to 2·55 volts: this is only 0·17 volt. The continuation of the curve shows the drop of P.D. on breaking the charging circuit; there is an instantaneous fall of 0·28 volt per cell, and a further fall of 0·1 volt in the E.M.F. in two hours.

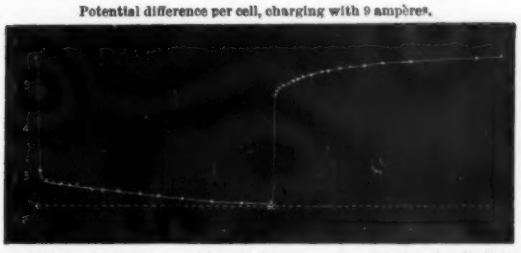
Potential difference per cell, charging with 9 ampères.
Charging circuit broken.
Time in minutes.
Charging circuit closed.

FIG. 4.

The curve on fig. 4 shows on a larger scale this drop on breaking the charging circuit when the cells are very well charged, leaving it broken for five minutes, and then closing it again; the charging current in this experiment being 9 ampères. There is, we see, a nearly instantaneous drop of the terminal P.D. per cell from 2·56 to 2·31, then a steady fall in the E.M.F. from 2·31 to 2·24 volts in five minutes. On reclosing the charging circuit at this moment, there is an instantaneous rise of the P.D. to 2·48 volts, and then a slow rise to 2·56 volts in five minutes; so that after reclosing the charging circuit it took, in this experiment, the same time for the P.D. to recover the value it had just before breaking as the time during which the circuit remained broken.

Experiments were also made on the time rise of the E.M.F. on stopping the discharge. Later on, however, the time rise of the E.M.F. on breaking the discharge circuit, as well as the time fall of the E.M.F. on breaking the charging circuit, for various currents, was measured in a far more sensitive way than in the early

part of this investigation; this subject will, therefore, be left until farther on in this paper.

On starting a discharge the P.D. generally falls slightly to the value that is maintained fairly constantly during a long portion of a discharge. After a prolonged rest, however, we have found that the P.D., on the contrary, shows a *decided rise* at the commencement of a discharge, and that it is not until the third discharge takes place that the curve resumes its normal character with the slight drop in the value of the P.D. at the commencement of the discharge.

II.—Efficiency.

In the earlier of the experiments made by us on the efficiency two distinct groups, each of 10 cells, were employed. The current passing through the two sets of cells also passed through two platinoid strips, and the P.D. at the terminals of each of these platinoid strips was measured by a suitable low resistance galvanometer, whose indications, therefore, measured the respective currents passing through the two sets of cells. The P.D. at the terminals of either group of cells was measured by means of a high resistance D'Arsonval galvanometer, which by means of a switch could be connected with the terminals of either of the two groups. The high resistance and one of the low resistance instruments have been absolutely calibrated very frequently during the past few years, by means of the silver voltameter, known resistances, and Latimer Clark standard cells. A special calibration was also taken of these instruments, both just before these experiments were commenced, and at their conclusion.

Group No. I. of 10 cells was first charged with 9·05 ampères and discharged with 9·933 ampères, there being four discharges alternated with four charges, without intermission, from January 8th to January 12th, 1889, both days inclusive. One of the observers was always present (day and night) to keep the current constant by hand regulation, to take frequent readings of the P.D. at the terminals of the set of 10 cells, to stop the charging when the P.D. per cell reached 2·4 volts and immediately start the discharging, as well as to stop the discharging when the P.D. per cell reached 1·6 volts, and instantly start the charging again, so that the cells were never left discharged.

We used the limits 2·4 and 1·6 volts per cell as the criterions for stopping respectively the charge and discharge since, as already seen, the slope of the charge and of the discharge curves are greatest for about these values of the P.D.

Next, Group No. I. was charged with 4·519 ampères and discharged with 9·933 ampères, twice, without intermission, from January 14th to January 19th, inclusive; the P.D. limit for charge being 2·4 volts, and for discharge 1·5.

And while the two sets of tests were being made with Group I., Group II. was first charged with 9·104 ampères, and discharged with 4·858 twice, without intermission, from January 9th to January 12th. And lastly, Group II. was charged with 4·519 ampères, and discharged with 4·858, without intermission, from January 14th to January 19th, both days inclusive.

Shortly, then, the tests were—

	Charge.		Discharge.
Group I.	9	...	10 ampères.
	4½	...	10 ,,
Group II....	9	...	5 ,,
	4½	...	5 ,,

The coarse adjustment of the resistance for keeping the current constant was effected by means of resistance coils made of bare German silver wire suitable for standing large currents; the fine adjustment was performed by means of horizontal mercury troughs, through which the current passed, the lengths of the mercury in the wooden troughs through which the current passed being varied by copper bridge-pieces. This mercury trough arrangement forms an extremely convenient resistance for delicate adjustment by hand. To keep the current as constant as possible, a dynamo was not used to charge the accumulators under test, but they were charged instead from other accumulators of much greater storage capacity.

The general expressions for the ampère hours and watt hours given out by an accumulator are, of course,

$$\int_o^{t_1} a_1 \, dt, \text{ and } \int_o^{t_1} v_1 \, a_1 \, dt,$$

where a_1 and v_1 are the current in ampères passing through the accumulator, and the P.D. at its terminals at any moment, and t_1 is the time in hours during which the discharge lasts. Consequently, if a_2, v_2, and t_2 have similar meanings for the charge, the complete expressions for the quantity and energy efficiency are, respectively,

$$\int_o^{t_1} a_1 \, dt \div \int_o^{t_2} a_2 \, dt,$$

and

$$\int_o^{t_1} v_1 \, a_1 \, dt \div \int_o^{t_2} v_2 \, a_2 \, dt.$$

In our experiments a_1 has a constant value during the discharge, and a_2 a constant value during the charge, so that the expressions for the quantity and energy efficiency reduce themselves to

$$\frac{a_1 \, t_1}{a_2 \, t_2},$$

which is very easy to calculate,

and

$$a_1 \int_o^{t_1} v_1 \, dt \div a_2 \int_o^{t_2} v_2 \, dt.$$

To obtain $\int_o^{t_1} v_1 \, dt$ a time curve of the values of v_1 is drawn and integrated; similarly, to obain $\int_o^{t_2} v_2 \, dt$ a time curve is drawn for v_2 and integrated; then, multiplying the first integral by the steady value of the discharge current a_1, and the second integral by the steady value of the charge current a_2, we have, respectively, the watt-hours given out in the discharge and the watt-hours put into the accumulators in the charge.

After drawing a series of time curves for the P.D. in the various experiments already referred to, and integrating them with an Amsler's integrator, we obtained the following results for the successive charges and discharges:—

Group of 10 *Cells—No. I.*

Discharge at 9·933 amperes.		Charge at 9·05 amperes.		Percentage.	
Ampere hours.	Watt hours.	Ampere hours.	Watt hours.	Quantity efficiency.	Energy efficiency.
119	2,280	114	2,435	105	94
105	2,045	102	2,220	103	92
101	1,970	101	2,220	100	87
104	2,020	104	2,270	100	89
Discharge at 9·933 amperes		Charge at 4·519 amperes.			
112·5	2,170	115	2,485	98	87
113	2,190	115	2,485	98	88

Group of 10 *Cells—No. II.*

Discharge at 4·858 amperes.		Charge at 9·104 amperes.		Percentage.	
Ampere hours.	Watt hours.	Ampere hours.	Watt hours.	Quantity efficiency.	Energy efficiency.
154·5	3,005	138·5	2,910	111·5	103
141·5	2,770	129·7	2,820	109	98
Discharge at 4·858 amperes.		Charge at 4·519 amperes.			
143	2,785	141	3,075	102	90·5

Now not only are quantity efficiencies of 105, 103, 111, 109, &c., per cent. impossible, but energy efficiencies of 94, 92 per cent. are also too high, when accumulators are being charged and discharged at the maximum rate allowed by the manufacturers. Further, it is noticeable that for each set of tests both the quantity and energy efficiencies diminish on the whole as the tests proceed. These cells, like the other cells in the Central Institution laboratories, have been charged at regular times; and as the number of ampère hours taken out of them for ordinary laboratory work varies very much, the intervals between the periodic chargings are so arranged that on the whole the cells are charged up much more than they are discharged.

Hence at the commencement of these tests the cells had a large store of energy in them on which to draw in the discharges, the results of which are given in the preceding table. From this we learn this very important fact—that *if accumulators be thoroughly well charged up before being tested, then five days' continuous charging and discharging alternately with even the maximum currents allowed by the manufacturers fails to give the normal quantity, or energy, efficiency.*

It will be noticed that both the ampère hours and the watt hours are increased by diminishing the current employed. This is partly due to the fact that if a fixed P.D. limit per cell be employed either in discharging or charging, the cell is discharged until the E.M.F. is slightly lower, and charged until the E.M.F. is slightly higher for a small current than for a larger one.

III.—Automatic Current Regulator.

We think it possible that a neglect of the power that accumulators possess of drawing on a store of energy put into them in former chargings may have led experimenters to conclude that the normal efficiency of certain types of accumulators was greater than was really the case. To ascertain the *working efficiency* of the accumulators we were testing, it was clear that they would have to be charged and discharged alternately with a definite charging and a definite discharging current continuously for a much longer period than five days. And as this would be a very laborious operation if the current had to be kept constant day and night during this period by hand regulation, we proceeded to construct the automatic current regulating device shown in fig. 5.

A is a set of five accumulators under test, where B is a totally independent set of four used to provide the power for working the current regulator. C is a platinoid strip of sufficiently large cross section and surface that no appreciable change of resistance can take place by the largest current—10 ampères—that flows through it in these experiments. D is a permanent magnet motor, the rotation of which in either direction turns the brass roller, E, F, very slowly in one direction or the other, the pinion and toothed wheel of the motor, combined with the small grooved pulley on the toothed wheel shaft and the much larger grooved pulley on the roller, causing the angular motion of the roller to be about $\frac{1}{100}$th of the angular velocity of the armature of the permanent magnet motor. The brass roller, E, F, is electrically divided into two halves by the ebonite disc, G, and little amalgamated discs at the ends of this roller turn with but little friction in mercury cups, H, I. Round each half of the roller are wound four bare platinoid wires of No. 26 gauge, and each about 4½ feet long. Their lower ends are soldered to the brass roller, and their upper ends to the brass bar, J, K, small spiral springs (not shown in the figure) being introduced to keep the wires taut. The rod, J, K, is held up by a cord which passes over two pulleys, and to the end of which is attached the weight, L. An electric current entering at H follows the path, H, E, J, K, F, I, the path being longer or shorter depending on the amount of the platinoid wires wound on the two halves of the brass roller. M is a solenoid, being, in fact, the coil of an A. and P. ammeter, on the axis of which a rod, P, Q, was very delicately poised by its being supported by four very fine wires of No. 40 gange, and each about one foot long. Two of the wires, N, on a plane at right angles to the path, joined together where they were connected with the rod at Q, but spread out at the top, and similarly O consisted of two wires. Thus, while the rod, P, Q, had great freedom of motion along its axis, it could not wobble sideways. This rod consisted of two pieces of brass at its ends, but the middle shaded portion was the well-annealed soft iron tubular core of the ammeter. A current passing round the coil, M, sucked in the core more or less against the pull of the antagonistic spiral spring, P, P′. This spring was made of platinoid wire of No. 26 gauge, wound round a ¾-inch mandril, and when pulled out in position it had about 30 turns to the foot, and was over 4 feet in length. One end of the spring was attached to the rod at P, while the other, P′, was fastened to a fine thread, which could be wound up more or less round a small roller and the tension of the spring very delicately adjusted.

At first the elasticity of this spring was not perfectly constant, but after about one month's use the pull it exerted when stretched to a given length became wonderfully definite, and the core, P, Q, could be adjusted so that for a current of exactly 9 ampères flowing round the solenoid, M, the projection at P remained midway between the contacts, R and S, without touching either. But on the current flowing round the solenoid, M, becoming very slightly greater, or very slightly less, than 9 ampères, the platinised projection of the rod at P made contact with either the platinised piece, R or S. The permanency that the spring eventually attained was so great that even when the apparatus had not been in use for two or three weeks, one had only to close the circuits to start the regulator, and no fresh adjustment whatever of this spring was necessary to ensure that the current would be kept absolutely constant at 9 amperes. This spring has, however, now gone the way of most bare fine platinoid wire, of breaking up into pieces.

When the cells, A, under test were being charged by means of a set of accumulators not shown on the figure, but attached to the leads, T and U, three copper bridge-pieces were put in to connect the mercury cups, 4 to 5, 2 to 6, and 1 to 3, respectively; whereas when the test cells were being discharged two copper bridge pieces connected the mercury cups, 2 to 3 and 5 to 6. The current passed, of course, one way through the cells, A, in charging, and the other way in discharging; but in both cases a positive current flowed, as indicated by the arrows, through the thick lead, V, the platinised strip, C, through H, E, J, K, F, I, through the thick lead, W, the thick lead, Y, the solenoid, M, and the thick lead, Z. As already explained, if the currents through this circuit exceeded in the very least 9 ampères, the core, P, Q, was sucked into the solenoid, M, until P made contact with R; whereas if the current fell in the least below 9 ampères, P, Q was pulled back by the spring, P, P′, until P made contact with S. In the former case a small auxiliary current from the accumulators, B, follows the course, *a*, *b*, *c*, *d*, through the spirals, *e*—several in number, so as to carry the current, but made of extremely fine wire, so as to oppose practically no resistance to the free motion of P, Q—then from P to R, through *f*, the electro-magnet, *g*, and through *h*, back to the other pole of the battery, B. If, instead, P be in contact with S, then the current from the auxiliary accumulators, B, passes from P to S through the relay electro-magnet, *i*, instead of through the relay electro-magnet, *g*. In the former case the spring tongue, *k*, is attracted so as to make contact with M (M being in reality a mercury cup into which dipped a platinum point with which *k* was tipped), and in the latter case the spring tongue, *l*, is attracted so as to make contact with *m*. If *k* makes contact with *m*, a positive current commencing from the middle of the accumulators, B, follows the path, *n*, the motor, through *o*, *m*, *k*, and back to the end of the accumulators, *p*; whereas if *l* makes contact with *m*, a positive current follows the path *q*, *a*, *l*, *m*, *o*, the motor, through *n*, and back to the middle of the cells, B.

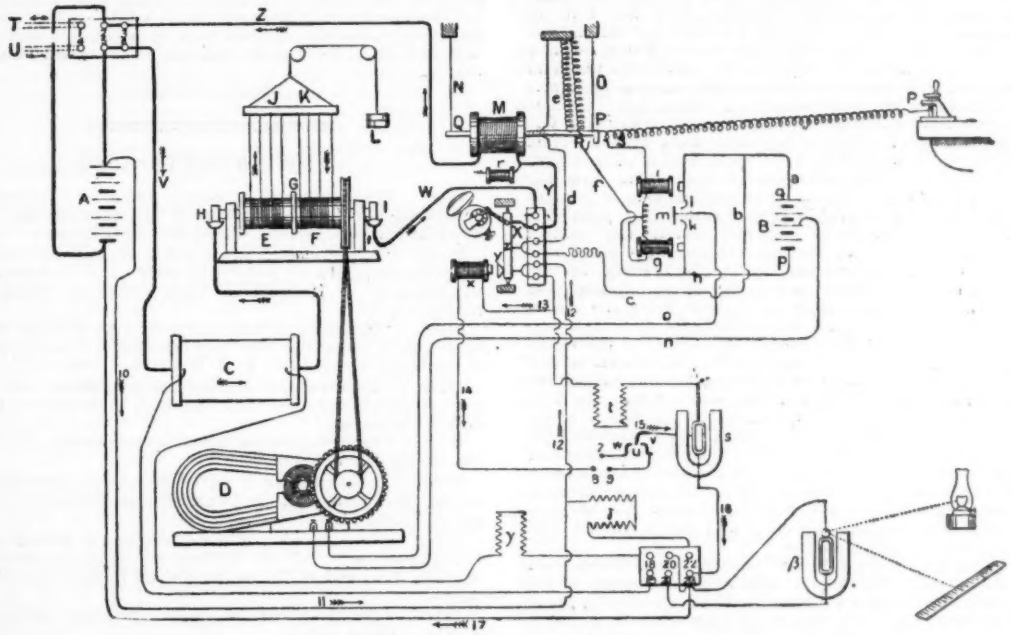

FIG. 5.—AUTOMATIC CURRENT REGULATOR, AND AUTOMATIC INTERRUPTOR FOR BREAKING THE CHARGING AND DISCHARGING CIRCUITS.

Accordingly, then, as P makes contact with R or with S, a current is sent one way or the other through the armature of the permanent magnet, D, and the roller, E, F, is turned around one way or the other so as to unwind, or wind up, more of the wire and automatically alter the resistance in the circuit. Although the whole apparatus was home-made, and looked very rough, it was able to automatically keep the current constant to 1 part in 600 for days at a time.

As the charge was effected with 9 ampères, and the discharge with 10, a shunt, *r*, exactly nine times the resistance of M, was connected across M during the discharge, and as the automatic regulator kept the current through M constant at 9 ampères, it kept the current through the circuit constant at 10 when the shunt, *r*, was attached to M.

The necessity of using the relay electro-magnets, *g* and *i*, arose from the fact that the only suitable permanent magnet motor which was at our disposal was a laboratory hand magneto Gramme machine, which required a current of about one ampère to work it, and to obtain great sensibility, the contacts between P and R, or P and S, had to be too slight to carry such a current.

It was very interesting to watch the regulator, since the armature of the motor was almost always in motion, now making half a turn one way, now one turn the other. It may be mentioned that one turn of the motor armature shortened or lengthened each

of the platinoid wires by about the 62nd of an inch—that is, by less than the $\frac{1}{1000}$th of its whole length.

At first all sorts of plans were tried for keeping clean the surface of the mercury in the mercury cup, *m*; but alcohol floated on the mercury failed because it dried up, water was electrolysed, oil was carbonised, and a long conducting point adhered to each of the platinum points, *l* and *k*, and the auxiliary accumulators, B, were short-circuited. In despair, we left the surface of the mercury completely exposed to the air, and were surprised to find that that answered perfectly; a thickish layer of mercury and mercurous oxide formed on the top, but the platinum wires easily forced their way through, and always made good contact.

To avoid, however, all risk of accidents, cut-outs were introduced into various parts of the circuit; and to prevent the motor overwinding the platinoid resistance wires on the roller, E, F, and breaking them, should the current in the main circuit accidentally become much too small, as well as to prevent the motor unwinding the wires too far off the roller should the current become much too large, safety keys (not shown in the figure) were provided. If the rod, J, K, were drawn down dangerously low, or allowed to go up too far, it touched one or other of the safety keys and broke the electrical circuits.

IV.—Automatic Interruptor for Breaking the Charging and Discharging Circuits.

As it was extremely important that both the charging and discharging circuits should be broken at the exact moment when the P.D. in its rapid variation passed through certain specific values, and as in a long course of experiments, lasting for several months, it was quite possible that occasionally no one of the observers would be present at the exact moment, we arranged an interruptor to break the circuit automatically when the P.D. in charging reached 2·4 volts per cell, or 1·6 volts per cell in discharging. The automatic interruptor was arranged thus:—*s* is a D'Arsonval galvanometer, the coil of which, wound with platinoid wire of 154 ohms resistance, is joined in series with a resistance box, *t*, as a shunt to the accumulators, A, under test. Electric connection was made to the bottom of the coil by means of a fine spiral spring, too thin to introduce any controlling moment, while above the coil was suspended by a phosphor bronze strip $\frac{1}{1000}$th inch thick, $\frac{13}{1000}$ths broad, and 1¼ inches long. This strip has seven twists put into it by means of a head moving in a tight collars, the coil being prevented from turning by a pointer, *u*, attached to the framework of the coil coming into contact with the stop, *v*. The thin phosphor bronze strip being very thin, it had very little torsional rigidity, and being set up as described, this instrument acted as a "set-up voltmeter"—a type of instrument proposed years ago by Prof. Perry and one of the authors of the paper for measuring with great accuracy a very small change in a P.D. With a definite adjustment of the resistance in the box, *t*, the platinum-tipped pointer, *u*, remains in contacc with the stop, *v*, for all P.D.'s between the terminals of the accumulators, A, less than 2·4 volts per cell. When the P.D. reaches this value, the pointer at once leaves the stop, *v*, moves over through an appreciable distance, and makes contact with the platinum-tipped stop, *w*. With another definite adjustment of the resistance in the box, *t*, the pointer, *u*, remains in contact with *w* for all P.D.'s between the terminals of the accumulators, A, greater than 1·6 volts per cell, but the moment this value is reached the pointer moves away from *w* and makes contact with the platinum-tipped contact stop, *v*.

When charging, a copper bridge piece connects the mercury cups, 7 and 8, and when on the P.D. at the terminals of the accumulators, A, reaching 2·4 volts per cell, the pointer, *u*, passes over and makes contact with *w*, an instantaneous small current is sent by the accumulators, A, through the electro-magnet, *x*, which, attracting the armature, *y*, downwards, tilts the spindle, *z*, and thereby lifts x and the other two contact forks out of the three sets of mercury cups, thus breaking *all* the circuits. The tilting of the spindle, *z*, also brings a camel's-hair brush into contact with the balance of a watch, and stops it at the moment the charging is completed.*

In discharging the cells, A, mercury cup 7 is connected to 9 instead of to 8. During the discharge the pointer, *u*, rests against *w*, and on the terminal P.D. of the cells falling to 1·6 volts per cell, the pointer moves over, comes into contact with *v*, and an instantaneous current passes round the electro-magnet, breaks all the circuits, and stops the watch. The course of this instantaneous current at the end of the charge and discharge is indicated by the arrows numbered consecutively 10, 11, 12, 13, 14, 15, 16, and 17.

To prevent any sluggishness in the action of this interruptor from a possible sticking of the pointer, *u*, against the contact stops, *v* or *w*, the pedestal supporting the set-up galvanometer, *s*, was kept in a constant state of slight vibration by the going of an American clock works that were placed on this pedestal.

V.—Ammeter and Voltmeter.

There remain only to be described the ammeter by means of which the current passing through the accumulators could be measured from time to time in order to see whether the automatic regulator was doing its duty, and the voltmeter for frequently measuring the P.D. at the terminals of the accumulators, A, under test. As the current had only to be very occasionally measured, one D'Arsonval galvanometer, *β*, was employed for both purposes. Its coil was wound with platinoid wire of 52 ohms resistance, and suspended in the way that has been already described,* which enables the deflection from one end of the scale to the other to be absolutely proportional to the current. The top suspension was a phosphor bronze strip $\frac{1}{1000}$th inch thick, $\frac{11}{1000}$ths wide, and about 1¾ inches long; while electric contact was maintained with the bottom of the coil by means of an extremely fine A. and P. spring, offering no appreciable torsional rigidity. The permanent magnets employed belonged to an old magneto machine, and into the cylindrical space between their poles, in which the Siemens armature formerly turned, was put a coil made of the right shape to suit the curved ends of the magnets without it being necessary to employ any soft iron pole pieces. Experiment showed that the deflection right across a scale 2 feet 9 inches long, the zero for no current being at one extreme end, was rigorously proportional to the current—a result which, as has been already pointed out, is far from being obtained with D'Arsonval galvanometers as usually constructed.

When it was desired to measure the current passing through the accumulators, A, a rocking switch was turned so as to connect mercury cup 18 to 20 and 19 to 21; whereas when it was the P.D. at the terminals of the accumulators that was to be measured, the rocking switch was turned so as to connect mercury cup 20 to 23, and 21 to 22. In the former case, with a resistance of 264 ohms on the resistance box, *γ*, a current of 10 ampères passing through the cells and platinoid strip, *c*, produced a deflection of 500 scale divisions, or 50 divisions per ampère; while, with a resistance of 71,570 ohms in the resistance box, *δ*, a P.D. of 10 volts at the terminals of the five accumulators, A, under test produced the same deflection; so that 50 divisions corresponded then with 1 volt.

(To be continued.)

* As it was undesirable to risk an expensive watch, we purchased one of the watches that could be then obtained in St. Paul Churchyard for 3s. 5½d. This watch was very substantial, had a very strong hair spring which could not be easily damaged, and was an excellent time keeper—far superior to many watches of a far more expensive character.

* See paper on "Galvanometers," *Phil. Mag.*, July, 1890.

NEW PATENTS—1890.

10125. "Improvements in electric cut-outs or apparatus for controlling the flow of currents of electrical energy." J. L. Kimball and H. C. Wirt. Dated July 1. (*Complete.*)

10134. "Improvements in covered or insulated electric cables or conductors, and a compound therefor." J. Y. Johnson. (Communicated by J. H. Cheever, United States.) Dated July 1. (*Complete.*)

10137. "Obtaining motive power by a method and means, or apparatus in connection with any mechanical or electrical motor, or combination of both." P. H. Williams. Dated July 1.

10179. "Improvements in telephone call devices." H. J. Haddan. (Communicated by F. R. Spalding, United States.) Dated July 1. (*Complete.*)

10181. "Improvements in secondary batteries." T. M. Foote. Dated July 1. (*Complete.*)

10183. "Improvements in electrical cut-outs, and fixtures connected therewith." H. H. Lake. (Communicated by S. Bergmann, United States.) Dated July 1.

10187. "Improvements in or appertaining to self-exciting electric generators." W. P. Thompson. (Communicated by W. Stanley, Jun., and O. B. Shallenberger, United States.) Dated July 1.

10211. "Improvements in electric primary batteries." V. Fabris. Dated July 2.

10229. "Improved means for decomposing sewage water by oxidising zinc by electric current." A. Green. Dated July 2.

10252. "Improvements in electric railways." J. P. Bayly. (Communicated by T. A. Evans, United States.) Dated July 2.

10271. "An improvement relating to medico-electric batteries." N. Mitchell. Dated July 2.

10276. "Improvements in electric search lights and in mechanism for feeding the carbons." H. J. Allison. (Communicated by B. B. Ward, United States.) Dated July 3.

10305. "A combined electrical comb-curler and curling tongs for hair." W. H. Fassett. (Communicated by R. Scott, United States.) Dated July 3.

10309. "An improvement in adjusting electric light suspenders." A. Lucas and E. Sundborg. Dated July 3.

10316. "Improvements in joints for armoured electric conductors." J. D. F. Andrews. Dated July 3.

10342. "Cleaning knives. Intended to be called 'Coomer's electric knife cleaner.'" G. M. Coomer. Dated July 4.

10359. "Improvements in connection with the electric lighting of ships." T. W. Watson and A. H. Watson. Dated July 4.

10406. "Improvements in electrical measuring instruments." J. Perry. Dated July 5.

10421. "An improved method or means for the prevention of accidents from the overheating of electrical wires." J. Bradford. Dated July 5.

10445. "An improved electric prod-pole." J. P. Bayly. (Communicated by J. Burton, E. Roach, R. Mac Nair, W. P. MacNair, and C. Lanning, United States.) Dated July 5.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

5066. "Improvements in sockets or holders for incandescent electric lamps." P. A. NEWTON. (Communicated from abroad by A. Swan, of America.) Dated March 23. 8d. The holder is composed of insulating material of a plastic nature, such as papier maché, moulded preferably to the form of a truncated cone. The base of the cone is recessed to receive the base of the lamp, through which pass the insulated wires leading from the carbon filament to insulated contact plates or rings on the surface thereof. The holder is pierced with ducts or passages for the leading wires from the electric main circuit, and recesses are provided in connection with these ducts containing contact plates or terminals. 19 claims.

5623. "Improvements in and connected with telegraphic apparatus for transmitting orders or other communications," G. A. CALVERT. Dated April 2. 11d. Consists in applying to the receiving instrument of the telegraphic apparatus a device to cause a bell or other sounder to sound or continue sounding in the event of the person receiving an order or communication making a mistake in the direction in which he moves a lever or other part when obeying the order or acting in consequence of the communication. 5 claims.

6728. "Improvements in the method of and means for the distribution of electrical energy by alternating currents." GISBERT KAPP. Dated April 20. 8d. Claims:—1. In a regulating transformer, subdividing the primary or thin wire coil into sections and connecting each of the sections with a multiple contact switch, substantially as and for the purpose hereinbefore described and as indicated by the drawings. 2. A regulating transformer in which the induction through the secondary or thick wire coil is varied by altering the relative positions of the two coils and their cores, and of a third or intermediate core, substantially as described and as illustrated by the accompanying drawings. 3. A regulating transformer in which the induction through the secondary or thick wire coil is varied by the motion of a movable magnetic bye-pass, substantially as described and as illustrated by the drawings.

7600. "Improvements in electric indicators." B. C. C. CANT. Dated May 7. 6d. Consists of a new form of armature which bears on its outer side a small lug and a new form of flag, having at the apex of a circle a small curved lug which engages and is supported by the lug on the armature when by a quick motion of the electric current the lug is disengaged and the flag falls, indicating in which room or place the circuit has been made. There are various devices for better adjusting the correspondence of parts. 1 claim.

7719. "Improvements in electric or galvanic elements or cells." Dr. P. SCHOOP. Dated May 8. 6d. Claims:—1. An electric or galvanic element or cell having an acid or saline exciting body or electrolyte in a solidified or thick gelatinous state produced by adding water glass (*i.e.*, silicate of potash or of soda) to a solution of an acid or of a saline substance, substantially as described. 2. An electric or galvanic element or cell having a solidified or thick gelatinous alkaline exciting body or electrolyte produced by adding to an alkaline liquid a solution of a salt of iron, such as sulphate of iron, either alone or mixed with hydrate of soda or water glass, substantially as described. 3. The production of an exciting body or electrolyte, such as hereinbefore referred to, by the conversion of an acid or saline solution into a solidified or thick gelatinous mass by means of a solution of water glass, substantially in the manner described for the purpose specified. 4. The production of an exciting body or electrolyte, such as hereinbefore referred to by the conversion of an alkaline solution into a solidified or thick gelatinous mass by means of a solution of a salt of iron, such as sulphate of iron, with or without admixture therewith of hydrate of soda or of water glass, substantially as described. 5. In the production of an electric element or cell of the kind referred to, the use of fibrous substance, such as asbestos fibre, in the manner and for the purpose set forth.

CORRESPONDENCE.

Secondary Battery Manipulation.

I send the following experience in case it may be of any interest.

Last year I filled in the spaces between the plates of my accumulators with plaster of Paris and sawdust in a dry state, intimately mixed, and then put in the usual dilute acid to which a little carbonate of soda had been added. I used these cells in conjunction with a dynamo driven by a turbine for lighting purposes; they were last charged early in November of last year, and on returning here late in June, I found that they burnt the lamps at their usual brightness, and that the E.M.F. of each cell was just under 2 volts. I also found that the cells had lost very little of the liquid through evaporation.

W. J. S. Barber-Starkey.

Knockshandoch, Glen-Isla, Alyth, N.B.
July 9th, 1890.

Lubricating Oils.

If, from the report in a contemporary journal of a recent case of litigation, arising out of some experiments with a particular kind of lubricating compound called *valdoline*, we may draw any conclusion from the evidence of the witnesses, especially one describing himself as a mechanical engineer, we shall probably be led to believe that this particular compound is an unfailing lubricant for such work as is included in electric lighting, or that, as stated in the evidence of the plaintiff company, it is a complete failure for electric machinery. But this brings the subject of lubricants before us for more general thought, and compels us to enquire into the particular advantages, special and general, claimed for innumerable compounds possessing ordinary and oftener extraordinary names, and, as a rule, very ordinary lubricating properties. For what particular object there should be such a desire on the part of oil sellers and inventors, as they often term themselves, to make their lubricants as complex as possible by mixing really good mineral oils with all manner of rubbish in the shape of acid fats and oils of animal and vegetable origin, is not easily explained. It can be supposed that every lubricant "inventor" has his own particular fancy of what constitutes a good lubricant, and maybe has the idea that by making the lubricant complex in character, and by giving it an attractive or, more generally, repulsive name, it will command a ready and profitable sale under "good pushing men."

If we follow the experience of those works where engines and machinery are running continuously from year to year, we obtain some reliable data as to the lubricants which give the greatest satisfaction, and it behoves those electrical engineers who have the charge of heavy and continuous-running machinery to follow, as far as may be practicable, the experience acquired by others under similar conditions. Now, what is the experience of engineers regarding lubricants? I have gone to considerable trouble to ascertain opinions of reliable men in many mills and factories, and who are not to be "bought" or bribed by the cleverest of oil touters, and they are unanimous in recommending pure hydro-carbon, or, as generally termed, mineral oils of various specific gravities, in proportion to the work being done. There are such things in the market as pure mineral lubricating oils, and can, I believe, be easily obtained at a reasonable price. One thing I would point out is that the purest oil put in a dirty tank or cask will most assuredly become gritty by the actual suspension of fine grit, generally fine silica, especially if the oil be very dense; and this is often the cause of sudden screeching bearings. The grit can be separated by washing the oil in water and allowing to settle; but it is best to avoid the cause by watching the barrels.

Probably the tricks of oil touters exceed any other calling in general engineering. It was actually admitted to me by an engineer in charge of an electric plant at an exhibition in London that the oil he used, and that most abundantly, was that which was "watered" the most! But jobbery of this kind should be completely quashed; not in lubricants only, but in bigger fields where it is known to exist, in the electrical world.

James C. Richardson.

Telegraph Statistics in Australia.

In your issue of February 14th you publish certain statistics purporting to be the postal and telegraph statistics of the colony of New South Wales. As the figures you give are so entirely erroneous, I am desired by Mr. Cracknell, the Superintendent of Telegraphs, to

forward you the correct figures (attached), with the request that you will kindly correct the errors.

Arthur C. F. Webb.
FOR THE SUPERINTENDENT OF TELEGRAPHS.

Electric Telegraph Department, Sydney,
June 9th, 1890.

TELEGRAPH STATISTICS.

	Corrected figures from official reports.	Figures as given in the ELECTRICAL REVIEW.
No. of stations	485	210
Total mileage of lines open for traffic December 31st, 1889	10,732	5,436½
Total mileage of wires open for traffic December 31st, 1889	22,606	9,921
Total mileage of lines opened during year	143	145½
Total mileage of wires opened during year	488	291
Total mileage of lines dismantled, ditto ...	102	145½
No. of local and inter-colonial telegrams transmitted	3,415,545	918,454
No. of cables from this colony per International cable...	10,271	...
No. of cables from this colony per New Zealand cable	9,746	...
No. of cables to this colony per International cable...	8,649	...
No. of cables to this colony per New Zealand cable	8,225	...
Revenue of telegraph department... ...	£186,861	...
Expenditure of telegraph Department alone	£178,931	...
Revenue of telephone department ...	£13,360	...
No. of subscribers on Sydney and district exchange	1,161	600
(In addition to this exchange there are exchanges at Newcastle, Maitland, Bulli, Wagga, and Albury)		
Total mileage of lines in progress... ...	293	11¾
Total mileage of wires in progress... ..	400	23¾

Electric Traction.

However faint Mr. Stove's praise of the Lineff conductor may be, I should like to ask for what reason the demonstration of its capabilities on 25th ult. is not to be regarded as conclusive.

The crucial points with regard to any sectional traction conductor are :

1. Its reliability.
2. Security to the public.
3. Efficiency, under which may be included the proportion of the power consumed by the picking-up apparatus, and so lost for traction purposes, and the underground and surface leakage.
4. Cost of maintenance.

To take these points in the order in which I give them, I will examine whether any difficulties may be expected to occur in a line of three or four miles on my system, that have not already been met with and overcome in laying a length of 75 yards.

1. *Reliability.*—Since the experimental line was laid down, in no instance has the contact with the conductor been lost, except when (the battery circuit on the car being disconnected) the dynamo has been stopped for the purposes of experiment. During the time the car has run a very considerable number of miles, and as the number of moving parts in the conductor is identical for a short or long length of line, it is absolutely immaterial whether the mileage is made up by many short runs or a few long ones.

2. *Security to the Public.*—Here again the fact of there being only one moving piece in the conductor makes a length of 75 yards quite sufficient for demonstration. No additional element of doubt is introduced by increasing the length of line. From the laws of probability it is clear that the chance of any one of n switches going wrong is greater than that of any particular one doing so ; so that in a line dependent upon separate switches for its action the uncertainty increases with the length. In the case of my conductor, however, there is no such increase, for the simple reason that the car, so to speak, carries its own switch with it, and this switch having been demonstrated to work satisfactorily over runs aggregating many miles, it is clear that under this heading, as under the former, the length of each individual run is immaterial.

The existence of a subsidiary wave in my hoop iron, in addition to the main one occurring under the moving magnet, has been thoroughly tested for, and it is proved that there is no such subsidiary wave within the limits of the line I have laid down. That a principal wave $\frac{1}{4}$-inch high should induce a secondary wave at a distance of over 75 yards is, as I think you will admit, so very remote a possibility, that it is quite unnecessary to contemplate it.

3. *Efficiency.*—The power absorbed by the picking-up magnet is obviously a constant quantity, and bears a constant ratio (about $\frac{1}{20}$th) to the mean power required to drive the small car. It will be less than this on a full sized vehicle. No difference on this head can accordingly occur on a long line.

With regard to underground and surface leakage, a judicious application of Ohm's and Kirchoff's laws will enable satisfactory conclusions for a line three or four miles long to be drawn from observations made on a length of 75 yards.

4. *Cost of Maintenance.*—This, I admit, can only be arrived at by subjecting the conductor to the same conditions as would exist when it was in practical use. But let us see what this means. It would be necessary to run a number of cars for a year or two on a public road before any demonstration took place. If this is not a contradiction in terms, it is so obviously an utterly impracticable expedient, that no apology need be offered for letting events proceed in the reverse order.

With regard to speed, I am at a loss to know how the statement that we had run here at 30 miles per hour originated, as it is clearly an impossibility. My car is geared to run at eight miles per hour, which is the maximum that will be allowed in the streets. Considering that I can start the car, attain this speed, and bring it to rest, all within less than half the length of the track I have laid down, I certainly think my line is long enough to demonstrate the capabilities in the way of speed so far as tramway traffic is concerned.

There are still one or two points to consider in Mr. Baines's letter. In the first place, he seems to think that the same tests are equally applicable to the third rail (by which I suppose he means the parallel), the series, and accumulator systems. Now, sir, is not some distinction necessary ? The parallel system being perfectly well established needs no demonstration of its general principles, and a new method of making the connection between the moving car and the conductor can be adequately tested by means of a comparatively short length of line and a single car. On the other hand, the series system certainly requires the use of at least two cars before it can justify its name. Again, an accumulator system cannot be considered as "demonstrated" till the life of the storage cells is determined, and the number of cars and length of track have nothing to do with this.

As to the points on which Mr. Baines wishes to be enlightened, I may say that rain, having no access whatever to the charged main, cannot possibly affect the uncharged surface rails, and that snow, whether wet or dry, will produce equally little result. With regard to clearing away snow, no great difficulty is to be feared. In America, where the falls are much heavier, the electric cars are provided with ploughs, and are able to run when horse cars are absolutely snowed up. In this country it is very rarely that the horse cars have to stop through snow, and the means already adopted for clearing the track in their case can also be applied with equal success to the magnetic rail of my conductor.

Mr. Stove's reply to Mr. Baines was, owing to my absence, sent on to you without being submitted to me, otherwise this detailed answer would have been forwarded last week.

A. Lineff.

July 15th, 1890.